# UNISPACE '82

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## REPORT AND HEARING

BEFORE THE

SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

SECOND SESSION

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COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C. 20515

## LETTER OF SUBMITTAL

Hon. Don Fuqua
Chairman, Committee on Science and Technology
U.S. House of Representatives

Dear Mr. Chairman: I am transmitting herewith the record of hearings that the Subcommittee on Space Science and Applications held last July on Unispace '82, the United Nations Conference on the Exploration and Peaceful Uses of Outer Space, and perhaps more importantly our report on: the hearings; the Conference itself, which was held in Vienna, Austria; and the preparation for and follow-up to the Conference. I believe that our report, though somewhat critical, is important and constructive because it points out the need for thorough preparation of United States delegations to such Conferences. The report also explains the significance of U.N. conferences.

Mr. Chairman, I have included a great deal of material in appendices to the hearings and to the report, in order to provide a full record of the impact of this Conference. I believe such a record will be very useful in helping the United States be better prepared for future U.N. Conferences of this type.

Several individuals assisted the Members in preparing this report and in preparing for the Conference. Overall staff direction and responsibility was exercised by Dr. Radford Byerly, Jr. He was assisted by Floyd Fowler, a fellow with the Committee, especially with respect to the hearings and the Congressional delegation in Vienna. We were also substantially assisted by Marcia Smith of the Congressional Research Service of the Library of Congress and Gordon Law, Richard DalBello, Adam Wasserman, and Ray Williamson, all of the Office of Technology Assessment.

Mr. Chairman, I commend this report to you and to the other Members of the Committee.

Sincerely,

Ronnie G. Flippo

RONNIE G. FLIPPO
Chairman, Subcommittee on
Space Science & Applications

# REPORT ON UNISPACE'82

# THE

# UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

Vienna, Austria
August 9-21, 1982

Subcommittee on Space Science and Applications

Committee on Science and Technology

U.S. House of Representatives

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## SUMMARY

Ninety-four nations vitally interested in space attended the UNISPACE '82 Conference. Therefore, the United States was presented a great opportunity to demonstrate its progress in space for the benefit of all mankind.

The United States did not seize this opportunity. The United States instead adopted a defensive posture and did not adequately accentuate its past accomplishments nor demonstrate its willingness to aggressively pursue cooperative international space programs. Although it can be argued that the United States did succeed in protecting its interests in the Conference, in some instances its public positions could be characterized as intransigent.

The single issue attracting most attention at UNISPACE '82 was "militarization of space." The United States virtually ignored this issue, for example in its plenary statement. This omission, following the President's July 4 space policy statement emphasizing military programs, signalled to many delegations that the United States is now mainly interested in military applications. Thus an opportunity to accentuate the positive -- the outstanding United States civil space program -- was missed.

The second most discussed issue was allocation of the geostationary orbit. Less-developed nations expressed concern that because of physical limitations the orbit will be "filled" before they can take advantage of it, although the finite lifetime of satellites means that slots will continue to open if "dead" satellites are pushed out of the orbit. The United States asserted that technological advances will mitigate these limitations but did not effectively demonstrate to other delegations how this would occur.

The United States chose to spend only a few months preparing for the Conference, and named its delegation only days before the Conference began. Thus, in part our defensive posture may have been due simply to lack of preparation of the delegation.

During preparations for the Conference, representatives of the Administration contended that the discussion would be technical and that political issues would not arise (e.g. this was stated at briefings and hearings). The opposite was true, the Conference was highly political, and not just technical.

The Congress could have been brought more effectively into the preparations for the Conference. For example, Congress was given the "official" position on certain issues, and was not made privy to how the issues would be dealt with at the Conference.

There was not enough private sector involvement in the Conference. Representatives of the entrepreneurial private sector should have played a larger role in UNISPACE because the future of the United States' civil space program probably lies largely in that sector, while in most other nations space is a nearly exclusive government function. As it was, few private sector representatives -- delegates or exhibitors -- were asked or allowed to participate substantively in the Conference or in preparations for it.

Many delegations from developing nations seemed vitally interested in benefits space could bring to them, especially in communications and remote sensing. Several nations stressed the importance of LANDSAT data continuity.

At the same time the developing nations were wary of possible negative impacts of space technology on their national interests even in communications and remote sensing. In communications, for example, concern was expressed that direct broadcasts from satellites to individual receivers would introduce unwanted information into their countries. Concern was also expressed that the "open skies" policy of the United States, i.e. non-discriminatory access to remote sensing data, would disclose secret information about the sensed country to its adversaries. The United States must address these inherently political issues.

The United States should recognize that United Nations conferences are a fact of international politics and plan to take advantage of them. These conferences must be prepared for carefully and wisely,and attended by a well-informed, coordinated delegation in order to best represent and advance U.S. interests.

## ACRONYMS

| | |
|---|---|
| CD | U.N. Committee on Disarmament |
| COMSAT | A U.S. satellite communications corporation |
| COPUOS | U.N. Committee on Peaceful Uses of Outer Space |
| CRS | Congressional Research Service, Library of Congress |
| DBS | Direct Broadcast from Satellite to individual ground receivers |
| ESA | European Space Agency |
| FAO | Food and Agriculture Organization of the U.N. |
| GSO | Geostationary Orbit |
| INTELSAT | International Telecommunications Satellite Organization |
| ITU | International Telecommunications Union |
| LDC | Less Developed Country |
| MARISAT | International Maritime Satellite Organization |
| NASA | National Aeronautics and Space Administration |
| NGO | Non-Governmental Organizations |
| OSAD | U.N. Outer Space Affairs Division |
| OTA | Office of Technology Assessment |
| UNCSTD | U.N. Conference on Science, Technology and Development |
| UNDP | U.N. Development Programme |
| UNDRO | U.N. Disaster Relief Organization |
| UNEP | U.N. Environment Program |
| UNESCO | U.N. Educational, Scientific, and Cultural Organization |

# XII

## I.

## INTRODUCTION

The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE'82) was held in Vienna, Austria, August 9-21, 1982. This chapter discusses the charter for UNISPACE '82; the historical background for the Conference; and the particular history of the U.S. preparation for UNISPACE '82.

### Charter for Unispace

A primary purpose announced for UNISPACE '82 was to discuss and possibly reach agreement concerning policies and programs for international cooperation in the peaceful uses of space. The conference was to review and assess: space science and technology; the application of space technology for economic and social benefits; and international cooperative programs related to space, especially programs to benefit the developing countries. The conference was required to prepare a report on its work (which at this writing is going through editorial preparation for printing) for subsequent transmittal to the U.N. General Assembly.

UNISPACE would also consider measures to ensure the wider utilization of space technology for the benefit of all nations, especially developing countries. In particular, the delegates were to examine how the U.N. could play a more effective role in this field.

In addition to its formal purpose it was intended that the conference would serve two other functions: First, by bringing together senior administrators, managers, and technologists from many nations the conference would permit a sharing of space experiences, accomplishments, difficulties and concepts; Second, the actual convening of UNISPACE '82 would generate and focus awareness of both the general public and policy-makers on space technology and applications.

In short, UNISPACE presented the U.S. with an opportunity to demonstrate and document its space leadership "for the benefit of all mankind."

(The formal agenda of the Conference is given in Appendix I.)

## History

The U.N. interest in the peaceful uses of outer space was manifest as early as 1957 when the General Assembly urged member states to consider an inspection system to ensure that outer space would be used for peaceful and scientific purposes. The U.N. Committee on Peaceful Uses of Outer Space (COPUOS) was established in 1959 to provide a focus for U.N. activities related to space. COPUOS has, through its legal subcommittee, developed five international instruments dealing with: the peaceful uses of outer space; liability for damage caused by space objects; registration of objects launched into outer space; rescue and return of astronauts; and principles governing the use of the Moon and other celestial bodies.

Interest in space activities (generated largely through COPUOS) stimulated the convening of the first U.N. Conference on the Exploration and Peaceful Uses of Outer Space which was held in Vienna in 1968. Seventy-eight countries and thirteen international organizations took part in this first international conference devoted to the practical applications of space technology. Dr. Kurt Waldheim, at that time Chairman of COPUOS, served as Secretary-General of the conference. The two main objectives of the 1968 conference were (1) to examine the practical benefits to be derived from space research and exploration based on achievements in this area and the extent to which non-space powers (particularly developing countries) might enjoy those benefits in terms of education and development; and (2) to examine the opportunities available to non-space powers for international cooperation in space activities, including the role of the United Nations in these matters.

At the conference, the Soviets unveiled plans for Intersputnik, their global communications satellite system. Technical details of the Intersputnik system were not discussed at Vienna, although Soviet delegates did say they planned to expand the Soviet Molniya system into a global network. The United States saw the Intersputnik proposal as a communist-bloc answer to the then 62-nation International Telecommunications Satellite consortium (INTELSAT) which handled more than 95 percent of the world's telecommunications traffic at that time. The State Department felt another global system was unnecessary. (To date, there are only 15 members of Intersputnik, all friends of the Soviet Union, while INTELSAT has 106 member nations.)

The conference generated two proposals that later were submitted to COPUOS by India and Sierra Leone. These culminated in (1) the creation of a United Nations

Space Applications Program, which provides technical assistance to developing nations through workshops, seminars, and training, and (2) the establishment of working groups in COPUOS to study questions concerning remote sensing, broadcast satellites, and other space matters of international importance.

Recognizing that since 1968 rapid progress and growth in space technology and its application had occurred, the General Assembly decided on November 10, 1978 that a second U.N. space conference should be convened, and COPUOS was named the preparatory committee. The General Assembly considered that there was a need to assess space technology developments, to exchange information and experience on their present and potential impact, and to assess the adequacy of means to assure broad realization of the benefits of space technology.

In its resolution calling for the conference, the General Assembly recognized the importance of wide participation by many nations. Consequently, the Secretary-General of the U.N. invited all member states and representatives of many other organizations including, for example, the Food and Agriculture Organization, the World Meteorological Organization, the International Telecommunications Union, and the International Atomic Energy Agency, to participate in the Conference.

Ninety four nations, twenty-three international organizations, and eight U.N. offices or programs were actually represented at the conference. The attendance is described more fully in Appendix 2. However, it is clear from the numbers that virtually all interested nations and organizations were represented.

An Indian, Yash Pal, was Secretary-General for UNISPACE '82 and a Sri Lankan, Nandasiri Jasentuliyana, served as executive secretary. Jerry Grey, (U.S.A.) administrator for public policy for the American Institute of Aeonautics and Astronautics, was appointed and served as one of three deputy secretaries-general for the conference. The other two were Hubert Bortzmeyer (France) and Alla Massevitch (Soviet Union).

## U.S. Involvement

Early in 1981, after the Conference preparations had begun, the United States decided not to participate in some of the UNISPACE '82 preparations because of a disagreement at the United Nations over who would be named director of the Outer Space Affairs Division, which services COPUOS. It had been anticipated that this director would also serve as executive secretary of the UNISPACE conference. The director of the division, a Czech, retired and the United States had expected that his deputy, an American, would be named to succeed him; the Soviet Union insisted that another Czech be made head of the division. During 1981, the U.S. attended the COPUOS preparatory meetings for UNISPACE '82, but did not take part in any other preparatory activities such as submitting a national paper, naming a Deputy Secretary-General, or preparing a delegation or exhibit.

On September 21, 1981 a letter was sent to then Secretary of State Alexander M. Haig, Jr., from the following Members of the Committee on Science and Technology: Don Fuqua, Chairman; Larry Winn, Ranking Minority Member; Ronnie G. Flippo, Chairman of the Subcommittee on Space Science and Applications, and Harold C. Hollenbeck, Subcommittee Ranking Minority Member. The letter urged "an early, positive decision to participate in the second United Nations Conference on Space." The letter also said "Since the commitment to peaceful exploration and utilization of space represents what we as a Nation stand for, it would be unfortunate if the United States did not fully participate." On the same day the same four Members sent a similar letter to the Honorable James L. Buckley, Under Secretary for Security Assistance, Science and Technology. That letter also urged U.S. participation, but was more specific. For example, after referring to Soviet accusations that the Space Shuttle is a military vehicle and that the U.S. is planning to use the Shuttle to capture satellites of other nations, the letter went on to say, "To allow such claims to go unanswered by our government in a forum such as UNISPACE '82 would be a mistake."

These letters were answered on October 9, 1982 by Richard Fairbanks, Assistant Secretary for Congressional Relations. That letter is included as Appendix 3 because it outlines from the U.S. point of view the U.N. personnel dispute which almost kept the U.S. out of UNISPACE.

A settlement of the U.N. personnel matter was finally reached in December 1981, and the U.S. decided to participate in UNISPACE. This gave the U.S. only seven months to prepare for an event for which other participants had over two years. This short preparation time and its impact are discussed in the next section.

## II.
## PREPARATORY ACTIVITIES

Because the U.S. was late in committing itself to attend UNISPACE'82, preparatory activities were less than optimum. The Committee on Science and Technology arranged several briefings and participated in several other meetings and briefings. The Committee also requested that the Congressional Research Service and the Office of Technology Assessment prepare background papers. Finally, the Committee held one day of hearings to familiarize itself with the issues and perhaps more importantly to encourage the Executive Branch to organize its delegation and positions well in advance of the Vienna conference. These activities are described briefly in this section.

### Early Activities

Because NASA had been involved significantly in international space activities all along, when the United States did decide to participate in UNISPACE'82, the NASA Division of International Affairs initially took the lead in United States preparations. As part of their efforts they wisely convened more-or-less regular meetings of involved Federal agencies. These meetings ensured a good degree of coordination among all parties involved in the preparatory activities, and as staff of the Committee on Science and Technology were invited to the meetings, the Committee had some insight into NASA's progress in developing a U.S. presence for UNISPACE'82.

Early in the spring of 1982 NASA briefed the Committee staff on their initial efforts at arranging a U.S. exhibit. At first prospects were somewhat discouraging--the U.S. was so late that there was no adequate space planned for them in the exhibition hall in Vienna. Eventually provision was made for a very adequate exhibit, and several major U.S. companies attended (as described below).

When the Department of State appointed staff and set up an office for UNISPACE'82, the lead role shifted to it. From that time, Committee staff were no longer invited to any interagency coordinating meetings that might have been held. The Department did arrange through the House Foreign Affairs Committee for two briefings on the preparations for the Conference. It was at these briefings that the basic U.S. position began to emerge. This position rested on two fundamental premises: The first premise was that the U.S. did not want the Conference to occur because we had everything to lose and little to gain. That is, presently we dominate space through our achievements, and we stand to lose some of this dominance through negotiation. Second, in order to avoid the possibility of any such negotiating losses, the initial U.S. negotiating position would be that UNISPACE'82 had only technical purposes and the U.S. would not agree that political issues should be dealt with by the conference. This is discussed more specifically below.

It should be pointed out that the agencies planning and preparing for the Conference were doing so at a time of great budget stress. No resources had been allocated for UNISPACE preparation, and they had to be found in a shrinking budget.

The Committee decided that it needed some sharply focussed background material, and therefore commissioned two short reports by the Congressional Research Service (CRS) and the Office of Technology Assessment (OTA).

Marcia S. Smith and Susan E. Crowe of the CRS prepared a report which became an Issue Brief, "UNISPACE '82: The Second U.N. Conference on Outer Space (IB82231)." This gave useful background on the Conference, described U.S. preparation, and listed issues for consideration. Ray Williamson, Adam Wasserman, Gordon Law, and Richard DalBello of OTA prepared a longer background report as part of a major ongoing assessment of international cooperation and competition in civilian space activities. The OTA report expanded on the international politics surrounding UNISPACE'82 and the controversial issues to be discussed there and very usefully described possible political consequences of the Conference. Both these documents are published in this volume as appendices to the record of the hearings described below.

## The Hearings

In May of 1982, the Speaker of the House notified the Chairman of the Science and Technology Committee that he had designated Members of the Committee as Congressional Advisers to UNISPACE'82. In anticipation of a need for Congressional input to U.S. preparations, as well as to equip Congressional Advisers, Chairman Flippo of the Space Science and Applications Subcommittee, scheduled an afternoon of hearings for July 14, 1982.

The hearings opened at 1:00 p.m. on July 14 in Room 2325 of the Rayburn House Office Building. The hearings were to acquaint Members with the issues that were likely to be discussed at the conference; to provide the

U.S. delegation an opportunity to describe preparations leading up to the conference; to provide Congress an opportunity to make inputs into the process; and to better equip the congressional Advisers to deal with policy issues resulting from UNISPACE'82. The Subcommittee invited representatives from the United Nations, from the U.S. delegation, and from the private sector. The witnesses were chosen to allow the Subcommittee to hear a description of the issues from the perspective of the U.N.; a description of preparations for a similar U.N. conference (the UN Conference on Science and Technology and Development, held in 1979); and a description by the U.S. Head of Delegation on U.S. preparations for UNISPACE'82.

The UNISPACE'82 hearing allowed the Members of Congress an opportunity to make inputs into the preparatory process that they would not otherwise have had at the hearing. Members reflected their concern about the preparation process, and also capitalized on the questioning period to make recommendations regarding potential U.S. initiatives at the Conference.

The Issues: A recurrent theme throughout the planning for the hearing and during the hearing itself was that there was not sufficient time for adequate preparations for Vienna. The concern stemmed partly from perceptions of a lack of preparation for earlier, similar U.N. and related conferences. This concern was heightened by the realization that there was a significant conceptual difference between the official U.S. position and many other countries about just what kind of conference this was to be. The principal concern was that, at the "eleventh hour", the U.S. was still insisting that this was a purely technical conference and therefore the U.S. Delegation was not preparing to discuss political matters. A secondary concern was that, even if the Administration resolved its policy problem with respect to discussing political issues, the naming of the Delegation would be so late that the delegates would have insufficient time to prepare for the relatively complex political issues that were sure to surface at Vienna. Of further concern was the fact that no attempts at defusing the political issues were evident in the preparatory meetings (at least there was no evidence of success).

A conference such as UNISPACE calls for extensive participation of U.S. industry in the displays and demonstrations. Thus, an additional concern stemming from our late start in preparations was the quality of the U.S. exhibit. Since private companies need to be concerned with budgets, transportation, and schedules, there was some fear that the U.S. image might be degraded if industry preparations were too late in getting underway.

One of the critical preparatory steps was the writing of the Draft Report of the Conference which would be finalized at the Conference. This Draft Report, put together by the Conference secretariat and revised by COPUOS, was based on National Papers submitted in the spring of 1981 by COPUOS members, and also on background papers from affiliated U.N. organizations. The U.S. paper was not submitted until March 1982 and U.S. views that might have been considered during preparation of the Draft Report were not taken into account. Had the U.S. submitted its National Paper earlier, it could have laid a basis for a more constructive U.S. presence at the Conference. It could have prepared the way for U.S. initiatives. As it was, the U.S. paper did little more than document past accomplishments.

## The Witnesses:

Dr. Jerry Grey of the American Institute of Aeronautics and Astronautics (AIAA) has been active for a number of years in the preparations for UNISPACE'82. Dr. Grey served as Deputy Secretary-General (one of three) for this conference. In this role, he worked for the United Nations and was not a part of the U.S. Delegation. The Subcommittee had issued invitations to both the Secretary-General for UNISPACE, Professor Yash Pal, and to Dr. Grey. The U.N. Secretariat, however, did not consider it appropriate for Professor Pal to testify, and so he declined. Dr. Grey testified for himself and did not officially represent the views of either the U.N. Secretariat or the U.S. Delegation.

Ambassador Jean Wilkowski, who is now in private life, brought the experience of having been an Ambassador in Africa as well as serving as Ambassador to the United Nations Conference on Science and Technology for Development (UNCSTD) which convened in 1979. Her role in that conference was identical to that of Ambassador Helman's in UNISPACE in that she served as the Deputy Head of Delegation and had responsibility for preparations for UNCSTD. While in the recent years there has been much criticism of the quality of U.S. preparations for U.N. conferences, UNCSTD has often been cited as an example of good preparation.

Mr. James Beggs, Administrator of the National Aeronautics and Space Administration (NASA), served as Head of the U.S. Delegation, with the rank of Ambassador. Mr. Beggs has the perspective of heading an organization, NASA, which is involved in many international agreements with several countries. NASA has been deeply involved in all aspects of the preparations for UNISPACE. Mr. Beggs was able to describe preparations for the conference from his double perspective of being Head of NASA as well as Head of the Delegation. Mr. Beggs was accompanied at the witness table by Ambassador Gerald Helman, U.S. Cordinator for UNISPACE.

Analysis: Upon examination of the testimony, the following conclusion emerges: The preparations by the United States were clearly not as extensive as for some similar, prior U.N. conferences. The U.S. participation in the United Nations preparatory activities was far less than it might have been. Also, as the delegation had not yet been named, preparatory activities by the U.S. delegates were non-existent as of the time of the hearing which took place less than four weeks prior to the opening of the Conference in Vienna.

That the preparations for UNCSTD in 1979 were very extensive is indicated by the following exchange during Ambassador Wilkowski's testimony:

> Mr. FLIPPO: How did third-world nations view the UNCSTD conference in 1979 in terms of political issues versus technical issues?
>
> Ms. WILKOWSKI: The LDC's considered it primarily a political confrontation, more than an opportunity to get into the substance of science and technology. There was an effort, it is true, on the part of some of the countries in hopes that we could get them to focus on specific projects in food and energy and health, but I think they saw it largely as an attempt to further their objectives under the new international economic order, and it was a question, I think, of more power, more authority within the United Nations system that was basically at the root of their objectives. It took us a little while to discern this.
>
> Mr. FLIPPO: And, discerning that, how did you prepare for that in the 1979 conference? How did you prepare for the political side of that conference? Did you involve the private sector? How did you approach that?
>
> Ms. WILKOWSKI: Well, in my prepared statement and also in a study which I did for Georgetown University, a case study on conference diplomacy, I pointed out that our political framework was not

> necessarily as strong as it might have been, but on the technical side, I think we were quite strong at Vienna because we engaged in what I think was perhaps the most extensive outreach program of any previous conference, going out to the private sector, going out to the science community, the business community, the PVO community. We had well over 200 American corporations engaged in research and analysis and policy recommendations.

From the past record and from the testimony in this hearing, the U.S. preparations for international conferences apparently benefit considerably from the extensive involvement of outside advisers. The consultations with Congress, the selection early-on of a citizen's advisory group, the seeking of counsel from key people in the industry and the appointment of a steering committee chaired by a strong, dynamic leader would appear to mark the more successful preparations (and none were done at more than a token level for UNISPACE). Ambassador Wilkowski indicates, in her prepared testimony, that the UNCSTD scored reasonably well in terms of the preparatory process:

> There were structured consultations with the Congress, indeed at least six general briefings and hearings, as well as individual encounters with the Coordinator and Delegation Chairman. There was Congressional interest and participation in Preparatory Committee meetings at New York and Geneva and there were extensive consultations with the private sector involving several hundreds of U.S. corporations, foundations, universities and institutions. The resulting analytic studies were a helpful guide to initiatives and strategies in the U.S. position for UNCSTD and would not have been possible without the foresight of Congressional authorization of funds to the National Science Foundation.
>
> Considerable technical help and political guidance for UNCSTD preparations was provided by an eminent group of senior advisers from in and out of the government who were brought together by the chairman of the U.S. Delegation to Vienna, Father Theodore Hesburgh, President of the University of Notre Dame. Called the Hesburgh Steering Committee, the group met quarterly at the Undersecretary level in the Department.

The witnesses provided excellent testimony on international conferences, on how preparations should be done, and on the difficulties one expects to encounter. All believed that the conference, in the words of Dr. Grey, "offers a major opportunity for the United States to promote its role as a good neighbor and as an important and significant power in the world." Dr. Grey saw an opportunity to make gains without large expenditure of U.S. funds. Dr. Grey was able to describe the U.N. preparations and to illuminate the key issues that remained unresolved prior to the conference. Ambassador Wilkowski's testimony reflected an attitude that U.N. conferences are a fact of international life and that we should prepare well for them. She provided excellent insight and recommendations on preparations as well as a baseline for Members to evaluate UNISPACE by her descriptions of preparations for UNCSTD. Ambassador Wilkowski was very diplomatic in comparing preparations for UNISPACE with those for UNCSTD.

The hearing served as a opportunity for those responsible for the U.S. preparations for UNISPACE to present to Congress the results of their efforts. Mr. Beggs and Ambassador Helman chose to submit one prepared statement. In their testimony, they reviewed the plans for preparations up to that time and stated that preparations were going well. They also reported that our presence at UNISPACE in August promised to be strong and effective. They said that the Administration viewed the conference as an opportunity for the U.S. to reaffirm its commitment to international cooperation and to emphasize our role as the world leader in space.

Their statement gave the primary purpose of UNISPACE'82 as "to promote greater international awareness of the practical benefits of the application of space science and technology."

The statement described the organization and status of U.S. preparations, with particular emphasis on the roles of NASA and the State Department Coordinator's office. It also discussed the role of the then yet-to-be-named U.S. Delegation in the preparatory process. The testimony recounted the background and some key history of the Conference. It noted the first U.N. space conference, described some results of that conference, and recounted space history during the intervening 14 years. It emphasized the international developments in space.

In his testimony, Mr. Beggs indicated that the U.S. has now resigned itself to the inevitability of political questions coming up at the conference and that the U.S. Delegation would be prepared to discuss them.

A U.S. initiative which did emerge in the questioning that followed Mr. Beggs' testimony was the Global Habitability initiative which was ultimately presented in Vienna (see below). Another initiative suggested by Members of the Committee was that of a peacekeeping satellite along the lines proposed previously by the French government to the U.N. Committee on Disarmament. This last suggestion, i.e. for an International Satellite Monitoring Agency, was not picked up by the U.S. Delegation, indeed, the Delegation adopted a position against such a proposal.

Summary: This hearing was useful in a number of ways. Congress is currently reviewing space policy. It was felt that this review might be complicated by negotiations at UNISPACE where militarization, prior consent, and similar issues would be discussed. Thus, this hearing was useful in alerting Members to the international dimensions of the issues. The hearing provided Congress with an opportunity to make indirect input to the preparations process. During the hearing, Members encouraged the U.S. Delegation to be prepared to address both technical and political issues; to be prepared to respond to inquiries on current space policy; and, to discuss international organizations for earth observation. They encouraged initiatives on the part of the United States and offered encouragement and assistance by Congress in preparing for UNISPACE'82.

A principal accomplishment of the hearing was to contribute to the preparation of Members of Congress who were to serve on the U.S. Delegation as Congressional Advisers. The Congressional staff, OTA, and CRS preparations leading up to the hearings and the able testimony of four distinguished witnesses served both to stimulate and to inform the Members. Dr. Grey as well as Mr. Beggs and Ambassador Helman articulated some problems the U.S. could anticipate at Vienna. All witnesses reflected the seriousness with which the U.S. must approach conferences of this nature. In the words of Ambassador Wilkowski: "The U.S. must accept the inevitability of conferences, draw on its institutional memory and employ its best diplomatic experience and skills so that these conferences can be used to serve U.S. National interests."

The testimony did not reveal the degree of attention that the issue of the militarization of space would receive in Vienna.

## III

## THE U.N. CONFERENCE IN VIENNA

### Delegations

The UNISPACE'82 Conference on the Exploration and Peaceful Uses of Outer Space was the second United Nation's conference on space; the first was held in 1968. All 157 U.N. member nations were invited to attend the conference but only 94 nations were represented. Also present were representatives of a variety of U.N. specialized agencies and programs with particular interests in space such as the International Telecommunications Union and the Food and Agriculture Organization.

The United States delegation to the conference was hand-picked by the Administration to represent various government organizations having space interests, Congress, aerospace companies, and other parts of the private sector. The delegation list is given in Appendix 4.

Unfortunately many of the U.S. delegates stayed for only a small part of the Conference. Because the House was in session, the Congressional Advisors could stay for only a few days. Few private sector representatives stayed for the whole conference.

### Conference Procedure

The August 9-21, 1982 UNISPACE'82 Conference was comprised of several activities:

1. The Conference itself. The conference included plenary sessions (where each of the U.N. member nations and associated U.N. and international groups could present a statement on space issues) and meetings of three committees (I, State of Space Science and Technology; II, State of Applications of Space Science and Technology; and III, the Role of the U.N. and other International Organizations) which dealt with issues relevant to each committee.

2. Exhibition. Here countries with space programs set up displays for conference delegates and the general public. The countries involved in the display included: U.S., U.S.S.R., European Space Agency, Canada, India and Japan. The U.S. companies present included: Rockwell International, Martin Marietta, Ford Aerospace, IBM, General Dynamics, Lockheed, RCA, Grumman, and International Imagery Systems, a small company involved in remote-sensing image-processing.

3. Non-governmental Organizations (NGO). The NGO conference represented interested individuals who wished to discuss topics of mutual interest concerning various space issues (energy from space, private sector involvement in the space program, space militarization, etc.).

Plenary Sessions: The plenary sessions of the conference allowed U.N. member nations and associated U.N. and international groups to present their statements on space issues, and was the forum for final resolution of controversial issues and approval of the conference report.

The conference was opened with a plenary session on August 9 with speeches by U.N. Secretary-General Javier Perez de Cuellar; the President of Austria, Rudolph Kirchshlaeger; and the Austrian Foreign Minister, Willibald Pahr, who had been elected to serve as President of the conference. During the remainder of the first week, 67 countries, 3 U.N. specialized agencies, 5 other U.N. bodies and programs, and representatives of 5 other intergovernmental organizations and observers for non-governmental organizations presented statements. The subjects covered in these remarks reflected the broad scope of space activities, and all but four of the countries mentioned the issue of militarization of space. Several countries also spoke about the situation in the Middle East, tying it to the theme of space by discussing the use of satellites in such situations.

The plenary was not scheduled to meet during the second week of the conference until the final Friday and Saturday, but a special meeting was called for Wednesday at which a group, designated the "Friends of the President," was established to develop for the report of the Conference compromise wording dealing with militarization. The group was chaired by Pahr, and consisted of representatives from 15 countries (3 from each regional group): The United States, the United Kingdom and Sweden; Saudi Arabia, India, and China; Columbia, Brazil, and Argentina; Egypt, Angola, and Nigeria; and Hungary, Poland, and the Soviet Union. The three paragraphs which were developed by this group (see Appendix 6) were adopted without further debate at the plenary session on August 21.

Two matters almost came to a vote during the plenary sessions on Friday and Saturday (August 20 and 21). The first concerned paragraph 25 of the rapporteur's report on the general debate which summarized statements made during the first week of the plenary sessions on the Middle East situation. On Friday, Algeria proposed extremely strong language condemning Israel by name for its activities in Lebanon. The United States did not object to reference to this issue, since it had been discussed in the plenary sessions, but did not approve of the mention of Israel by name. The rules of the Committee on Peaceful Uses of Outer Space do not allow the mention of countries by name in its reports in negative contexts, although it was pointed out that UNISPACE did not necessarily have to abide by the rules of COPUOS. Although several delegations called for a vote on the matter, Pahr deferred consideration until Saturday morning. By that time, compromise language had been developed, which, although still strong, did not mention Israel. The original Algerian proposal read:

"During the general debate, numerous delegations denounced the wrongful use of space techniques in cases of military conflict, such as surveillance satellites, and condemned the aggression committed against Lebanon and the barbarous massacres committed against the Palestinian and Lebanese civilian populations by Israel, as well as the assistance supplied to the aggressor."

The language which was ultimately adopted replaced the last two lines with: "Palestinian and Lebanese civilian populations perpetrated by the aggressor in defiance of international law and international morality as well as the assistance supplied to the aggressor in his expansionist policy."

The other matter which came close to being voted on was a proposal by Mexico that two documents expressing the positions of the Group of 77 be annexed to the report. The Mexican proposal was made after the rest of the UNISPACE report had been adopted by consensus. The United States objected to the Mexican proposal because it did not want any annexes to the report, since they would not have been considered in the same manner as the rest of the report. A number of delegations called for a vote on the issue, but Pahr succeeded in convincing everyone to attempt to work out a compromise and adjourned the conference temporarily. What was expected to be a 20 minute recess became a three hour interruption, but a compromise was reached whereby a paragraph was added to the summary of the general debate referring to the Group of 77 position papers and noting the concerns expressed therein.

Before coming to Vienna the United States had decided not to address the militarization of outer space since the conference was a forum for the peaceful uses of outer space. As mentioned above, almost every country except the U.S. expressed deep concern over militarization of outer space at the plenary sessions. This was highlighted by the Soviets who claimed that the new Salyut 7 space station is used solely for peaceful uses.

They described their cooperative space efforts with other countries, including socialist country cosmonauts and the French "Spationaut." They also mentioned how, after a promising beginning of cooperation in the Apollo/Soyuz mission with the Americans, the program stopped, "but it was not the fault of the Soviet side." The Soviets also said it is essential to take timely steps to prevent militarization of space. They said that "Aggressive forces are making plans for the militarization of space," and implicitly excluded themselves from that category.

The Soviets presented at the plenary session a television and sound transmission from the Salyut 7 space station for 20 minutes. This included ten minutes of live transmission and ten minutes of preprogrammed propaganda. The U.S., along with a number of other countries, protested the preprogrammed transmission.

A majority of the less developed countries (LDC) are firmly committed to an aggressive remote sensing program by developed countries. For example, Peru urged the beginning of a new dialog and new efforts to reach an agreement on remote sensing which should preferably deal with the needs of developing countries. The LDCs would like to reap the technology spinoffs of remote sensing to help in crop assessment, forestry management, rural disasters, geological and mineral mapping, etc.

Concerns were expressed by a number of countries (e.g. Greece, Mongolia, Ecuador, Algeria, and India) regarding prior consent before sensing. If neighboring unfriendly countries obtained remote sensing data for a particular country, this could be used for military and strategic purposes.

Many nations (e.g. Canada, Thailand, Uganda, Bangladesh, Upper Volta, Indonesia, Malaysia, India, and the Republic of Korea) and the Secretary General of the conference explicitly referred to the need for data continuity. Many others stressed the importance of remote sensing to them in various ways.

The U.S., U.S.S.R., Japan, and a number of European countries have taken the lead in communication satellites. Many LDCs expressed concern that when they are ready for their own communication satellites, there will no longer be room in the geosynchronous orbit (the orbit 22,300 miles above the earth's equator where satellites travel as fast as the earth, thus remaining in a fixed position with respect to the earth). For example, the Philippines and Kenya both asserted that the geostationary orbit is allocated on a "first come, first served" basis, although this is not strictly true. The U.S. believes that improving technology on the next generation of communication satellites will allow closer spacing among all satellites. Thus, in effect, the geosynchronous orbit is not as limited as some believe. Unfortunately the U.S. did not make a major effort to clarify this point and reassure the concerned countries. A U.S. slide show that could have helped was not widely shown or advertised.

Many LDCs are also concerned that the upcoming generation of direct broadcast satellites (DBS) which allow broadcasts from a satellite at geosynchronous orbit directly to small rooftop antennas could allow any country to transmit propaganda to other countries. For example, India believes the U.N. should establish a healthy code of conduct for DBS transmissions. LDCs hope that the DBS will be used in services such as remote medical information services, rural educational programs, and teleconferencing that will allow for close international cooperation in technological development. But they do not want DBS to provide automatic access to their countries. For example, Greece spoke of the need for "national filters" and India spoke of the need for consent and agreement arrangments. Korea said that the "trans-border flux" of information should be subject to the consent of the receiving nation.

Columbia declared national sovereignty above their country to include the geosynchronous orbit. They did this in spite of the fact that such a claim would violate the Outer Space Treaty (which they have signed) by claiming that "outer space" begins outside the geostationary orbit. On the other hand the Republic of Korea stated that while such claims of sovereignity should not be tolerated, any method for allocating geostationary orbit slots and radio-frequency spectrum must protect the needs of the developing states.

Issues Raised in the Plenary by Other Countries:

--In the future China intends to offer launch services to other countries.

--Equador will donate land on which a large radio telescope could be built for use by the entire international scientific community.

-- A number of LDCs believe that the technological "spin-offs" of developed nations should be distributed worldwide. Technology transfer must be accelerated.

-- Pollution by outer space debris should be studied to determine its effect on future space development.

-- The Soviet Union has a number of cooperative space research programs with other socialist countries.

-- The U.N. should establish a center for outer space and an International space information service.

Weather Satellites: Many countries mentioned the importance of weather data from satellites, but no issue was raised. There seems to be a belief that U.S. weather satellites will continue to operate as always, or at least that the data will be available continuously.

U.S. Plenary Paper: Ambassador Beggs presented a statement at the plenary session. The entire text is printed as Appendix 5 to this report. Ambassador Beggs' statement contained a brief message from President Reagan and emphasized U.S. involvement in international cooperative space projects -- more than 1000 projects with over 100 countries. The statement reviewed progress in space technology, and recommended that such technology be used to improve conditions on Earth. In general, it was a bland and unremarkable statement, probably reflecting careful review and sanitization by the Department of State and the Office of Management and Budget. For example, the Global Habitability initiative, which was expected to be the major, substantive U.S. proposal, was presented with so little crispness or definition that it did not appear to be an initiative, but only a rather vague idea that would be nice to pursue at some time in the future.

## Committees of the UNISPACE Conference

Draft Report of the Conference: As the product of the Conference was to be a report, and as it would be impossible to draft such a report from scratch in two weeks, a "Draft Report of the Conference" was prepared in advance by the UNISPACE secretariat and debated in the Committee on Peaceful Uses of Outer Space (COPUOS). A final draft was made available on April 20, 1982, well before the Vienna meeting. Most of the 430 paragraphs were agreed to in COPUOS, but 15 paragraphs were so controversial that agreement could not be reached and thus they were printed in the Draft Report in brackets. It had been hoped that at Vienna most effort could be focussed on the bracketed paragraphs, but as consideration of the draft report began (in the Committees) it became clear that many nations, both those who had attended the COPUOS meetings and others had objections (many minor, technical, or idosyncratic, but others of significance) to the previously adopted language. These were resolved through a painfully slow process of consensus. Typically, the bracketed paragraphs dealt with major issues which are discussed below by topic.

Committee Responsibilities: Committee I was given responsibility for review and projection of the current and future state of science and technology for space research and applications, and evaluation of the major developments in space science, technology, and applications as well as assessment of the usefulness of these developments to date. The committee had jurisdiction over the introduction (paragraphs 1-14) and chapter I (paragraphs 15-142), of the draft report, and was chaired by Robert Knuth of the German Democratic Republic. The committee was unable to complete its work in the six sessions which had been scheduled, so it also met twice on Saturday, August 14, and once on Monday evening August 16. Topics of special controversy within this committee included militarization, technology transfer, and geostationary orbit.

Committee 2 was assigned jurisdiction over the second chapter of the draft report (paragraphs 143-313) and was chaired by Minoru Oda of Japan (the vice chairman, Miguel Sanchez Pena of Argentina, chaired one afternoon session). The subjects under consideration by committee 2 included: evaluation of the current and potential application of space technology; examination of the possibilities and mechanisms for enabling all States to benefit from space technology; examination of the choices for utilizing space technology available to countries at various stages of development and of potential difficulties in this regard; examination of the existing infrastructure and scientific and technical development in various countries and of measures to assist them in deriving the maximum benefit from space technologies; examination of systems to use space technology for education; discussion of the compatibility and complementarity among various satellite systems; consideration of the implications of projected developments in space technology, including use of geostationary orbit; and discussion of the nature of, and ways of protecting, the near-earth environment. The committee could not complete its work in the 10 sessions which had been scheduled, so met in a special evening session on August 19. Many of the most controversial topics at UNISPACE were included in this chapter of the report, including geostationary orbit, direct broadcast satellites, remote sensing, and militarization.

Committee 3 had responsibility for the third chapter of the draft report (paragraphs 314-430) which dealt with international cooperation and the role of the United Nations, and was chaired by David Andero of Kenya. The Committee completed its work in its scheduled seven meetings. The matters considered by committee 3 included: reports on the nature and extent of bi- and multi-lateral cooperation in space; reports on activities of the U.N. and other international organizations;

the role of the U.N. and other international organizations in ensuring broad international cooperation on an equal basis; and the role of the U.N. in realizing the benefits of space technology for all countries and the possible need for enhancing its role. As with committees 1 and 2, this committee had to deal with the issue of militarization, as well as technology transfer and the proposal to create a U.N. Centre for Outer Space.

The three committees achieved consensus on all paragraphs in the report except the bracketed paragraphs concerning militarization (13, 205, 231, and 419), which were referred to the plenary (see discussion elsewhere in this report).

## U.S. Initiatives - Poster Sessions

During UNISPACE'82, the United States described a variety of initiatives it intended to pursue with other governments and interested agencies in order to apply space technology to problems on earth. The specific initiatives are:

-- Global Habitability

-- Communications Satellite Technology Seminar

-- Feasibility Study of the Development of an International Emergency Disaster Assistance Communication System

-- Conference on the Application of Space Technologies for Disaster Monitoring and Early Warning

-- Promoting Access by Developing Countries to New Remote Sensing Microprocessors

-- Annual Meeting of Space Technology Experts Attending the Scientific and Technical Subcommittee (STSC) of the U.N. Outer Space Committee

-- Conference and Sharing of Results of the U.S. Agency for International Development Rural Satellite and Related Program Utilization

-- Removal of Satellites from Geostationary Orbit

Several of these initiatives were presented at "poster sessions" which were very poorly attended. The U.S. tacitly admitted that it had failed to present these initiatives adequately when near the end of the Conference the U.S. succeeded in adding to the report of the conference language describing the U.S. initiatives, although the language adopted does not identify the U.S. by name and other initiatives are also mentioned. The initiatives are described below:

Global Habitability: The United States proposed an international cooperative research effort to obtain data on changes of natural or human origin, affecting the habitability of the earth. "Global Habitability" will focus on biological productivity and the water, chemical and energy cycles which comprise the life support system of the earth. Insofar as possible, models of these cycles will be developed and checked against data. International cooperation will be necessary for success of the initiative because the models will have to be based on and verified by data from many countries. In addition, international collaboration will be important in order to maximize scientific return, to achieve cost savings, and to avoid duplication. Many countries, including LDCs, will be able to participate in this effort by conducting ground based observations and exchanging data. Through such collaboration, participating countries will obtain vital information supplemental to that now obtainable through independent, unrelated activities. Such efforts will assist individual countries and regions in managing their resources and dealing with changes affecting them.

"Global Habitability" will contribute to the ongoing environmental research efforts of the WMO, FAO, UNEP, and other regional and international agencies.

The United States did not reveal that this initiative would involve no new funding immediately, but would be only a repackaging of ongoing U.S. activities.

Communications Satellite Technology Seminar: The United States in cooperation with the Hughes Aircraft Corporation, which will act as host, will hold a two-week seminar on space telecommunication technology in the autumn of 1983. This seminar will deal with the basic aspects of building and designing space telecommunications systems.

The seminar is intended to assist developing countries to improve their understanding of design and development of space telecommunications facilities. Many developing countries will need to establish, expand or upgrade access to and utilization of global and regional communications satellite systems and relevant associated technology. This need can be addressed by improved understanding of the design of such systems and how they can be most usefully applied.

This initiative will provide an opportunity for representatives of developing countries to visit facilities and organizations involved in space communications. The seminar will be designed to facilitate sharing of knowledge and to promote understanding of the practical applications of space communications technologies.

Feasibility Study of the Development of an International Emergency Disaster Assistance Communication System: The United States proposes that, under the sponsorship of the Outer Space Affairs Division, a working group should examine the following issues:

-- What are the specific needs for a global satellite disaster communications capability?

-- What would be the technical requirements of such a system, and what would be its costs?

-- How could the interested organizations and groups cooperate to establish and maintain such a capability at the lowest cost and how would such a cost be shared?

The working group could be composed of interested international organizations such as ITU, UNDP, UNDRO, UNEP, INTELSAT and others as appropriate. It would also include: private relief groups such as the International Red Cross, CARE, Church World Services, Catholic Relief Services; COMSAT; National Post and Telecommunication authorities; and ESA. Interested donor and recipient country representatives should also participate in the working group as experts or observers.

The prompt assessment of disaster needs and the efficient and timely collection and distribution of resources to alleviate these needs require good communications. These communications requirements include three categories: (a) local communications; (b) communications from the immediate disaster area to regional or national staging areas and headquarters; and (c) communications to international agencies providing disaster assistance. These categories entail differing time and resource requirements and coordinative efforts.

This initiative will promote the design and development of rapid communications systems linking disaster sites and the international response community. In this context, mobile earth stations can provide high quality communications from nearly any location on the globe. Station operation could be coordinated with an existing system, e.g., INTELSAT, MARISAT.

**Conference on the Application of Space Technologies for Disaster Monitoring and Early Warning:** In order that the use of Outer Space Technologies in assessing and reacting to natural disasters of varying natures and dimensions may be examined, the United States proposes to sponsor a five-day conference by the U.S. Agency for International Development, Office of Foreign Disaster Assistance in Washington, D.C., in the spring of 1984.

This conference would address problems in areas such as global drought assessment, agroclimate, famine early warning, and would consider how satellite based data and communication systems could be of assistance in these areas. Current operational systems--systems under development and future applicable technologies--would be examined.

Such a conference would make more generally available information on those technologies and their applications currently existing and suitable for operational implementation worldwide. The conference would help to focus international consideration of this important topic and assist in definition of future systems requirements. Opportunity would be given for participants, especially from developing countries, to examine new advanced technologies available to them. Participants at the expert level would discuss concrete mechanisms, including relatively sophisticated environmental monitoring systems which could mitigate the impact of natural disasters and save lives through preparation and early warning using satellite-based disaster early warning systems and data collection platforms.

**Promoting Access by Developing Countries to New Remote Sensing Microprocessors:** The United States, in order to assist in increasing the effectiveness of the use of remote sensing data in developing countries, plans to install in the Nairobi Regional Remote Sensing Center, a microcomputer with associated peripherals. This microcomputer can be used in more effective natural resource survey and environmental monitoring. Training in its use and maintenance will also be provided.

In the last few years, microcomputers have been developed which are linked on a desk top area with color display and appropriate terminals. These devices can be made available at about one-tenth the cost of larger more conventional computers, and can increase the capacity of states to absorb and process data in areas such as:

-- petroleum exploration through better geological mappings;

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-- preservation of renewable natural resources and forested watersheds;

-- change analysis of rangeland vegetation during seasonal migration of wild grazing animals from the Serengetti Plain in East Africa.

Annual Meeting of Space Technology Experts Attending the Scientific and Technical Subcommittee (STSC) of the UN Outer Space Committee: The United States, in cooperation with the Columbia University School of International and Public Affairs and beginning in 1983, will host a series of two-day meetings among representatives of agencies of governments responsible for space and space-related activities. The first of these meetings would be held February 3-4, 1983. The meetings would be held on an experimental basis for three years with the expectation that, if useful and feasible, they could become an annual event preceding the meeting of the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space.

The purpose of these discussions would be to exchange, on a senior technical level, information and ideas on current and planned space programs of particular interest to developing countries. New and increasing applications of space technology are making it more necessary that managers and developers of these technologies meet and discuss new developments on a regular basis. They would also provide a forum to facilitate informal coordination between countries with space activities. It is hoped that a meeting such as this would interest and attract the technical expertise available to the Scientific and Technical Subcommittee, contributions from academia and non-governmental organizations, and also involve those who influence political and resource commitments in the participating countries.

Conference and Sharing the Results of the U.S. Agency for International Development Rural Satellite and Related Program Utilization: The United States, through the Agency for International Development (AID) has developed its Rural Satellite Program to assist the growth of rural telecommunications. It is the intention of the U.S. to hold an international conference to share the results of this effort in 1985. This program will include three to five pilot projects of two year duration. The U.S. will soon begin field testing a combined low-cost satellite ground station and photovoltaic power system. Adapted for developing countries, this project will employ low cost, two-way earth stations which can be used with available satellites. The ground station, in the field, will be used in conjunction with stand-alone photovoltaic arrays for providing electricity in remote or rural areas for a variety of useful services.

The United States, using this technology, will be carrying out pilot projects in rural telephoning, audio conferencing and the operation of pumps, freezers, mills and other equipment. In order to share the results of this program with interested countries, the conference on rural satellite communications will be a tool in the dissemination of data derived from and through the program and in measuring the results of the program.

Removal of Satellites from Geostationary Orbit: the United States, recognizing the desirability of making efficient technical use of the geostationary orbit (GSO), has removed several satellites from the GSO when their useful lifetimes were completed. When practical and feasible, the United States Government intends to continue this practice with satellites presently under its control and those it launches in the future.

The U.S. believes that there are a variety of technical measures and technological advances which can help alleviate concerns expressed about the possibility of future "crowding" of the GSO.

## Exhibit

Exhibits of aerospace companies and products from countries including the United States, the Soviet Union, the European Space Agency, Canada, India, and Japan were open to conference delegates and the general public. Around 200,000 people (mostly the general public) visited the exhibits during the two week UNISPACE'82 Conference.

The U.S. exhibit was comprised of the following companies: Rockwell International, Martin Marietta Aerospace, Ford Aerospace, IBM, General Dynamics, Lockheed, RCA, Grumman, and International Imagery systems, a small company involved in remote sensing image-processing; together with an exhibit run by NASA. The U.S. exhibit did tell a good story about the civil space program, and despite getting off to a late start, the government-industry cooperative effort presented a good front for the U.S. A major fault of the U.S. exhibit (except for that of RCA) was that the displays were captioned only in English. As a result, the Austrian audience taxed the relatively few interpreters in the display booths with technical questions.

The exhibits of the other countries were captioned in German or German and English. The Soviet Union had an excellent display which included a scale model of the Salyut 6 space station, a slide tape show, a movie, and various displays of Soviet spacecraft and hardware.

## Non-Governmental Organizations (NGO)

The NGO conference was held in conjunction with the UNISPACE'82 meeting. The NGO conference was chaired by Dr. David C. Webb of the U.S. with the purpose of inviting speakers to address a multi-disciplinary audience on specific issues of interest. The NGO conference schedule follows:

Tuesday, August 10, 1982
Impact of Space on the Third World
Session Chairman, Rashmi Mayar

Wednesday, August 11, 1982
Space Environment and Bioresources
Session Chairman, Noel Brown

Wednesday, August 11 and Thursday, August 12, 1982
Energy from Space
Session Chairman, Peter Glaser

Friday, August 13, 1982
Private Sector Programs in Space
Session Chairman, Klaus Heiss

Saturday, August 14, 1982
Peace in Space
Session Chairman, Robert Bowman

Monday, August 16, 1982
Future Development in Space
Session Chairman, David Webb

Tuesday, August 17, 1982
Information from Space (Communications, Education, Remote Sensing)
Session Chairman, David Webb

Wednesday, August 18, 1982
Biomedical Implications of Space
Session Chairman, William Douglas

Thursday, August 19, 1982
Legal and Political Implications of Space
Session Chairman, P. Finch

Friday, August 20, 1982
Morning: Scientific Exploration of Space
Afternoon: Philosophical Implications of Space
Session Chairman: N. Kiefer

Saturday, August 21, 1982
Morning: Closing Session
Session Chairman: N. Kiefer

## Meeting with Members of Japanese Delegation

During the course of the conference the U.S. Congressional delegation held an informal meeting with the following Members of the Japanese delegation to UNISPACE: Dr. Shigebumi Saito, Commissioner, Space Activities Commission of Japan, Dr. Hiroshi Uda, Director of the Tsukuba Space Center, National Space Development Agency of Japan (NASDA), and Mr. Hideo Nakatsugawa, Director of International Space Affairs Division, Japan Science and Technology Agency. Our discussions were focused on the activities of the UNISPACE meeting as well as on United States-Japan bilateral relations in the field of space exploration. The Members of the Japanese delegation emphasized that in their view the space exploration efforts of the two countries appear to complement each other with the Japanese program limited to smaller launch vehicles, and unmanned probes while the United States program, with the Space Shuttle, provides heavy lift capability and a strong manned orbital capability. Our delegation agreed that this can serve as the basis for future cooperative activities, and the two sides agreed that exchanges of visits of legislators and policy makers between the two countries would be useful.

## Issues

Throughout the Conference, militarization of space was the issue that received the most attention. No other topic prompted the extended, emotional debate that was involved in militarization, although several other important issues were discussed, including the use of geostationary orbit, principles governing direct broadcast satellites and remote sensing from space, technology transfer, and the future role of the United Nations in space matters. Some of these issues -- such as militarization and direct broadcasting from satellites (DBS) -- are clearly not primarily technical issues. They divide societies in very basic ways. For example, the DBS issue matches the fundamental concepts of freedom of information versus those of government control of information -- concepts not easily subject to technical resolution. On the other hand, crowding of the geostationary orbit could be mitigated by technical means. The following summaries briefly review the discussions of these issues.

Militarization of Space: The issue of militarization of space, as expected by almost everyone except officially by certain members of the U.S. delegation, was a major topic of discussion at UNISPACE. The official U.S. position, both prior to and during the conference, was that militarization was appropriately not on the agenda of the conference because it had been assigned to the U.N. Committee on Disarmament (CD), not to the Committee on Peaceful Uses of Outer Space (COPUOS). Most other countries contended, however, that military activities could affect peaceful activities, and therefore should at least be mentioned in the UNISPACE report.

Four paragraphs in the draft conference report (13, 205, 231, and 419) contained language about militarization of space and were bracketed to indicate that no agreement could be reached on them during preparatory activities. A fifth paragraph, 314, was not bracketed, although it did contain a reference to this issue.

One distinction eventually made by the United States was between "militarization" of space, which would include all military-related activities (reconnaissance, navigation, etc.) and "weaponization" of space, or the concern that the arms race may extend into the space arena. The final solution in the UNISPACE conference report was to avoid the word "militarization" and use the phrase "arms race" instead.

Consideration of the Militarization Issue in Committees and Plenary: The opening session of UNISPACE dispelled any lingering thoughts that militarization would not be a major issue at the conference. The first three speakers -- U.N. Secretary General Javier Perez de Cuellar, Austrian President Rudolph Kirchshlaeger, and Austrian foreign Minister Willibald Pahr, who served as President of the conference -- all prominently raised the issue in their opening speeches.

At the start of the conference, Pahr recommended that an informal working group be established to deal with the four bracketed paragraphs on militarization. The Soviet Union objected on the grounds that the three committees had been established to deal with all paragraphs, bracketed and otherwise. The United States supported establishment of a working group only if it would deal with all bracketed paragraphs, not just those on militarization. No agreement could be reached and for the time being the idea was dropped.

Each of the three committees had responsibility for at least one paragraph on militarization: Committee 1 had paragraph 13, Committee 2 had paragraphs 205 and 231, and Committee 3 had paragraphs 314 and 419. Each of the committees in turn deferred consideration of the militarization paragraphs until the end because they were holding up the rest of the work. This included paragraph 314, over which the United States raised an objection at the beginning of Committee 3 deliberations (over the words "almost all" in reference to the number of nations that were concerned about militarization).

Because of these deferrals the first real debate over the issue did not take place until Monday, August 16. Committee I, meeting in evening session to conclude its work, began debating paragraph 13 at 9:00 p.m. After about an hour's discussion, the committee chairman decided to attempt to reach consensus on a sentence by sentence basis. Thinking there was agreement on the first sentence, he banged the gavel to indicate that the proposed language had been adopted. Simultaneously, the United States asked for the floor and when recognized, stated that the chairman should not assume that the U.S. agreed with any of the language that had been proposed for paragraph 13. After another 15 minutes of discussion, several delegations suggested that since the United States was the only country objecting to the language, it should propose alternative wording. The United States then responded that the problem was "conceptual" as well as verbal, and therefore there was no language to which it could agree. Realizing that the committee was at a stalemate, the chairman referred the issue to the plenary for resolution and adjourned at 10:30 p.m.

Committees 2 and 3, recognizing that they would get no further given the U.S. position on the matter, also referred their bracketed militarization paragraphs to the plenary. On Wednesday, August 18, the plenary met in a special morning session to establish a working group to deal with the bracketed militarization paragraphs, and this time the idea was accepted. The group, called "Friends of the President, was chaired by Pahr, and consisted of representatives of 15 countries (three from each regional group).

On Thursday, paragraph 314, which was not bracketed and therefore had not been referred to the plenary, resurfaced for consideration in committee 3. A special working group had been set up within the committee to develop alternative wording, and the language it proposed was adopted by consensus. The phrase "though recent trends of increasing military activities in space are a cause of great concern to almost all nations" was changed to "though recent trends leading to the extension of the arms race into outer space are of course of great concern to the international community."

The fact that the United States had agreed to this language was seen as a relaxing of its hard-line position taken earlier in the week. During this period, negotiations were progressing in the Friends of the President group, and on Friday, the results of those discussions were published in three paragraphs and then adopted without discussion on Saturday morning. Appendix 6 gives this language. The first two paragraphs will form a new paragraph 13; the last will form a new paragraph 419. Agreement had been reached in committee 2 where the language concerning militarization in paragraph 231 was dropped, while the rest of the paragraph remains. Paragraph 205 was deleted.

Group of 77 Position on Militarization: Although the wording developed by the Friends of the President was adopted by consensus at UNISPACE, the Group of 77 had circulated a document on August 13 strongly expressing its concerns about militarization and calling, *inter alia*, for a ban on the "testing, stationing and deployment of any weapons in space." After the conference report had been adopted on Saturday, August 21, Mexico stated that it wanted the militarization document, plus another Group of 77 position paper concerning remote sensing and direct broadcast satellites to be included as annexes to the UNISPACE conference report. The United States objected to having *any* annexes to the report. The conference adjourned for three hours while a compromise was reached whereby a paragraph was added to the "Summary of the General Debate" referring to the two Group of 77 documents, but they are not annexed to the report. Although the language is not contained in the report, the sentiments it expresses will be more difficult to ignore in the future. Appendix 7 gives the Group of 77 language.

Observations on the Militarization Debate: The United States was isolated in its steadfast rejection of language concerning militarization of space during the first week and a half of the conference. All other countries, including the Soviet Union, were willing to incorporate in the UNISPACE report some wording about the growing concern about the military uses of space. The preferred method of dealing with the issue differed from country to country (some wanted the language in the draft report retained as it was, others wanted all four paragraphs pulled together with only one mention of the issue in the report), but only the United States totally rejected the "concept" of including such language.

In the end, however, the United States did agree to language about the concern over the potential arms race in outer space. It is difficult to imagine why the United States chose to place itself in such a position *vis a vis* the other 93 countries at UNISPACE. There were rumors of deep divisions within the U.S. delegation as well as in Washington over what the United States should accept in this regard, and it is possible that no unified position emerged until the last days. At any rate, any debate over the U.S. position was not shared within the delegation. It is also conceivable that the

United States underestimated the level of concern of other nations about this matter, and hoped that once everyone had "gotten it out of their systems" (on August 16), the issue would go away. (This view in fact, was expressed at the U.S. delegation meeting the next morning, August 17).

Several friendly delegations expressed dismay that the United States appeared to choose to alienate itself on this issue, and strong remarks were often heard about U.S. attempts to stifle debate on militarization. The U.S. was criticized for being one of a small number of countries (all western) who did not openly address the issue in the plenary speeches during the first week, and for letting the Soviets sit back and watch with amusement while they supported the language that the U.S. would not. Indeed, it was unfortunate that the Soviet Union, which has the only operational antisatellite system, was able to assert the position of a defender of arms control in space while the United States appeared as the aggressor. Although the U.S. delegation publicly reminded the conference that an antisatellite system had already been tested in space, and not by the United States, U.S. stubbornness negated whatever effect that reminder might have had.

In addition, there was a feeling the United States had not played fairly during the Monday night deliberations over paragraph 13. Instead of stating at the outset that it had a "conceptual" problem and would not agree to any wording, it allowed the debate to continue for an hour and a half. In all fairness, the chief U.S. delegate at that session had stated initially that he did not think there would be agreement on the paragraph that evening, but the depth of U.S. objections was not known until 10:15 p.m., an hour and fifteen minutes into the debate. It is not known whether this was part of some overall U.S. strategy to let everyone have their say in the hope that the issue would then be dropped. Perhaps the U.S. was waiting in hope that someone else would object to the language of paragraph 13, although its virtual isolation on this issue was well known.

As friendly delegations were quick to point out, the informal working group which the United States had rejected (along with the Soviet Union) during the first week of the conference was eventually established, and if the United States had only agreed to its creation in the first place, the Monday night colloquy, which portrayed the U.S. in such a bad light, might not have taken place.

Some U.S. delegates argued that if the working group had been set up the first week, and agreements on wording made, then other countries would simply have demanded more during the second week. However, it might have been possible simply to delay agreement in the working group until late in the second week, so compromises would not have been necessary any earlier. In such a manner, the issue might have been considered in a calmer environment.

What the United States gained by this method of dealing with the issue of militarization, other than exasperating and angering some of its friends, is hard to deduce. Whether this will have any long term negative effects on U.S. relations with these countries is an open question, but it is very difficult to foresee any positive effects.

Geostationary Orbit (GSO): Five bracketed paragraphs in the UNISPACE draft report concerned the geostationary orbit (64, 150, 253, 281, and 284). The debate in committees I (paragraph 64) and 2 (all the others) was long and difficult on many of these paragraphs, especially the debate on whether or not wording should be included specifying that the equatorial countries should receive special consideration in planning for use of GSO.

Equatorial Countries and the GSO: Since 1976, when eight equatorial countries signed the "Bogota Declaration" which declared that they should have national sovereignty over that part of GSO above their land masses, the equatorial countries have been seeking some recognition of their special geographic position *vis a vis* GSO. With regard to GSO questions at UNISPACE these countries attempted to include language such as "taking into account the special interest of the equatorial countries" but these attempts were generally rejected, since several other countries felt that they, too, deserve special attention for geographical reasons (for example, the Scandinavian countries at high northern latitudes have difficulty in receiving transmissions from GSO satellites, and tropical countries have difficulty with satellite transmissions because of rain attenuation). Thus, they objected to the use of the term "equatorial countries."

The debate over this issue was particularly intense in committee 2 during consideration of paragraphs 281 and 284, both of which were partially bracketed. The United Kingdom had proposed deletion of a sentence which referred to the position taken by the equatorial countries regarding their special relationship with GSO. Eight equatorial countries (Brazil, Colombia, Equador, Gabon, Indonesia, Kenya, Somalia and Uganda) wanted to retain that language as well as two sentences at the end of paragraph 284 which stated: "Clearly, such a planning method should emphasize those uses which promote development, including education. It should also ensure equity, consider the needs of developing, tropical and far northern countries, and take into account the special interest of the equatorial countries."

These paragraphs had been deferred for consideration by the committee, and were finally taken up in a special night meeting on August 19. They were the last matters considered by the committee, and therefore the final hurdle to adopting that section of the report by consensus. As the end of the session approached (the committee had to conclude its business by 11:00 p.m.), a compromise was reached whereby the United Kingdom withdrew its objection and the other countries agreed to the following wording in paragraph 284: "Clearly, such a planning method should take into account the specific needs of the developing countries, as well as the special geographical situation of particular countries." Thus, specific reference to the equatorial countries was avoided. Indonesia was allowed to take a reservation to the adoption of this language in return for its agreement not to block consensus.

The Group of 77 issued a position paper that included a statement regarding its position on this matter in which it supported the equatorial countries. Seasoned observers of this debate stated that this was the first time the equatorial countries had received Group of 77 backing. Although the Group of 77 language is not contained in the UNISPACE report, it has been made a part of the official documentation of the conference and is carried here in Appendix 7.

Use of Frequencies: One expected area of controversy that did not develop was over language which called on the developed countries to agree to move their satellite services to higher frequency bands while leaving the lower bands (which have less expensive space and ground segments) to the developing countries. The paragraph containing this recommendation (150) was deleted with minimal debate.

Number of GSO Satellites: Paragraph 64 became highly controversial because some countries wanted to include reference to the actual number of satellites in geostationary orbit, and to break down their ownership by developed versus developing countries. The representative of the International Telecommunications Union (ITU), with which countries register the frequencies they plan to use for satellites, provided the delegates with the number of registrations that had been filed for existing and future satellites, but pointed out that this was not necessarily the same as the number of satellites. After a rather acrimonious debate, it was decided not to use such numbers in the report since their exact meaning would be unclear.

Principles Governing Direct Broadcast Satellites and Remote Sensing: The issue of adopting international principles regarding use of direct broadcast satellites and remote sensing has been debated at the United Nations for many years. At UNISPACE, the focus of the discussion was the need to reach final agreement on those principles. Paragraph 310, which had read "It may now be time for countries to agree, as soon as possible," on the legal implications of remote sensing and DBS, was changed to "It is now time for countries to agree...."

Attempts were made by some delegations to include language stating that DBS should operate only with the prior consent of the receiving country, but for the most part these attempts were rejected. The last sentence of paragraph 309, however, was changed to state that DBS "could affect the sovereign rights of States." The Group of 77 position paper expresses the view that DBS should be conducted only "in full respect for the sovereignty of states" and urged the General Assembly to approve principles for DBS.

A notable shift in the remote sensing debate at UNISPACE was the focus on the right of a sensed country to have access to data about itself on a priority basis. This is a new facet of the decade-old question of whether other countries could have access to remotely-sensed satellite data about the sensed state without the prior consent of the sensed state. This new facet of the argument is reflected in an amendment made to paragraph 172, which states: "The sensed State shall have timely and non-discriminatory access under reasonable conditions to the primary data obtained by remote sensing from outer space which relate to its territory." A somewhat stronger view is expressed in the Group of 77 document which states that they believe "sensed states should have timely and unhindered access on a priority basis at nominal cost, to all data and information obtained over their territories." Their position paper goes on to say that "dissemination of such data and information derived from it to a third party should not be done without the prior consent of the sensed country."

Technology Transfer/Needs of Developing Countries: A theme of the UNISPACE conference was assisting developing countries in benefitting from space technology, so the issue of technology transfer and the needs of the developing countries was a topic of considerable interest and debate. The bracketed paragraphs that dealt with these subjects were 8, 11 and 12 (considered in committee 1), 306 (committee 2), and 360 (committee 3).

A focus of the debate was the split between developing countries, which wanted language calling on countries having the technology to render them assistance, versus the developed countries, which wanted to emphasize that developing countries must assume responsibility for themselves. Both themes were ultimately reflected in the UNISPACE report.

Paragraph 306, which concerns materials processing in space, had contained the sentence: "International mechanisms might have to be formulated to ensure that benefits from such developments are available to all nations." After lengthy debate, the entire paragraph was deleted (the general subject of materials processing in space is discussed elsewhere in the report). Paragraph 360, which concerns international cooperation as exemplified by INTELSAT, INTERSPUTNIK, and the World Meteorological Organization, stated: "However, in order for the benefits of space technology to be fully exploited and particularly to be more widely available, there is need for a great deal more to be done." This was changed to read: "In order for the benefits of space technology to be fully exploited and particularly to be more widely available to the mutual advantage of all nations, more work is required."

Lengthy debate also took place over paragraphs 8, 11 and 12 in the introduction and a working group was established within committee I to develop compromise wording. Part of the problem resulted from confusion over the source of the subparagraphs in paragraph 8, which were excerpted from the report of the 1979 United Nations Conference on Science and Technology for Development (UNCSTD). Two of these subparagraphs (e and f), dealing with the need for developing countries to accept primary responsibility for improving their development, were bracketed and it was unclear to certain delegations whether they were from the UNCSTD report or were additions made by the United States. The issue was resolved by quoting directly from the UNCSTD report, rather than paraphrasing as had been done in the draft UNISPACE report.

Paragraphs 11 and 12 were reworked jointly. The first set of bracketed sentences in paragraph 11 were moved to paragraph 12 and combined with compromise language from the two alternative wordings that had been proposed for paragraph 12. One version of paragraph 12 focussed on the need for developing countries to accept responsibility for themselves ("it is obvious that the future of developing countries depends primarily upon themselves,"), while the other focussed on the need for increased international cooperation to help the developing countries derive optimum benefits from the application of space technology. As finally adopted by UNISPACE, the paragraph incorporates both ideas, and reads as follows:

"Space technology offers the potential to spur economic and social development of all countries. It is by no means the complete solution to a country's problems and neither can there be any generalized prescriptions for the use of space technology. However, it is often a more effective alternative for achieving a given goal, and can sometimes bring a qualitative change by doing things not possible through more conventional means. In this connexion, international cooperation should be seen and conceived as a major instrument in assisting all countries, especially developing countries, to derive the optimum benefits from the application of space technology. However the future of each country should rest primarily upon itself."

The second set of bracketed sentences in paragraph II were replaced with softer language. initially, they had read:

"In fact, only the developed countries can fully exploit these benefits. This state of uneveness is unfair and unreasonable. The international community should make common efforts to bring about a gradual change in the present situation. To this end, the developed countries with advanced technology, particularly the space super powers, should assume greater responsibilities."

The new language reads:

"The international community and in particular the developed countries with more advanced technology should intensify their efforts to promote the wider exploitation of space technology by developing countries."

It is unfortunate that throughout the conference the U.S. delegation did not choose to emphasize NASA's rather extraordinary record of transfering technology to the developing world. At one point in the Conference a delegate from the Soviet Union inquired whether the statement in paragraph 353 of the report (stating that the United States has had over 1000 agreements with over 100 countries) reflected not only current but also completed programs. Instead of using this question as a means to insert into the record a more detailed account of NASA's successful international programs, the U.S. delegate responded that "the record is accurate as it stands." When the Soviet question was repeated, with some scepticism, by the delegate from Nigeria, the U.S. delegate gave a similar response. This response, instead of engendering respect for the strong U.s. commitment to international cooperation, created an atmosphere of distrust. Future delegations to international space conventions should be prepared to take advantage of NASA's many successful international programs in order to demonstrate the true character of U.S. space activities.

Role of the United Nations: The draft UNISPACE conference report had once contained language calling for the creation of a U.N. Centre for Outer Space to incorporate and expand the existing work of the U.N. Outer Space Affairs Division (OSAD). Some countries, including the United States, were concerned about how such an expanded operation would be funded--whether it would be from the assessed budget of the United Nations or from voluntary contributions.

The preparatory committee for UNISPACE toned down the language in the original version of the draft report, suggesting that either a new Centre be created, or the activities of the OSAD could be strengthened, and asked that the financial implications be studied by the conference secretariat. Language was also added stating that most of the additional funding was expected to come from voluntary contributions, but that some activities would come from the U.N. budget and that the United Nations should therefore rearrange the priorities in its budget to provide for these expanded activities.

The financial recommendations were contained in paragraph 416, while the language on either expanding the activities of OSAD or creating a new Centre were in paragraphs 427-430 of the draft report. Even this diluted wording proved to be the subject of considerable debate, and a special working group was set up within committee 3 to develop compromise language. To the surprise of some delegations, several developing countries (including India) opposed creation of a new Centre. The new language does not make a choice between the two approaches (expanding OSAD or creating a new Centre), but rather defers the issue for consideration by the General Assembly. The wording about financial implications was retained in paragraph 416. (It has been estimated that the expanded activities would cost approximately $3 million per year, compared to the 1980-81 budget for OSAD of $830,000.)

General Observations: As with the case of militarization, the United States adopted a hard line on questions of prior consent, special consideration for the equatorial countries, and technology transfer. Unlike militarization, however, the United States was not alone in its position on these matters. The United Kingdom in particular was very supportive of the United States on many of these issues.

The final report avoids specific reference to prior consent for both remote sensing and direct broadcast satellites, although the compromise language, when coupled with the position papers of the Group of 77, clearly indicates the strong feelings of many countries on these issues. As noted earlier, the desire of countries to have priority access to remote sensing data about themselves is reflected in the report, although the adopted language does refer to access to data, rather than data and information as proposed by the Group of 77. Similarly, there is reference to the relationship between DBS and national sovereignty, although stronger wording, suggesting that prior consent should be a principle for DBS, was rejected. Language on technology transfer refers both to the developing countries' desire for greater assistance from the developed countries, and to the greater responsibility that developed countries want to see developing countries accept for themselves.

## IV

## POTENTIAL EFFECTS OF UNISPACE'82

UNISPACE'82 had the potential to affect two quite different categories of U.S. national interests. The first category, the one on which the U.S. Delegation focussed its attention, is the U.S. freedom to carry out its planned national programs in space in compliance with, and without inefficiencies derived from, international laws and regulations, or without undue influence from foreign pressures. The second category of interest is the U.S. ability to carry out, both now and in the future, activities which are intrinsically cooperative in nature--such as sales of remote sensing services or world-wide communications. This requires that other nations perceive the U.S. as a valuable partner both because of our technical virtuosity and because of our policies and attitudes towards other countries.

As UNISPACE'82 was not intended to enact laws or regulations, its influence on the first category of U.S.

interests was indirect in that it could influence but not direct rule-making bodies. For example, it could make recommendations to the U.N. General Assembly, and it could affect the ideas and attitudes which countries bring to other meetings such as the ITU Plenipotentiary which can assign radio frequencies and GSO slots. Its affect on the second category of U.S. interests was potentially more significant: UNISPACE was an arena in which political figures from many countries who are expected to have influence over their countries' space activities formed an impression of whether it will be desirable and feasible to work with the United States in the future.

Thus, the Conference must be seen as having had two outputs: the text of the Conference Report, and the ideas and attitudes which the delegations carried away with them.

As far as the Conference Report is concerned, it contains little or no language seriously inimical to the interests of the United States. The Draft Conference Report contained controversial language regarding such issues as the militarization of outer space, the _a priori_ allocation of the geostationary orbit and radio frequencies, the issue of prior consent in both direct broadcast satellites and remote sensing, and general issues regarding technology transfer to developing countries. This language was, for the most part, resolved to the satisfaction of the U.S. delegation and protects U.S. interests. Throughout the conference the U.S. delegation worked diligently at toning down or eliminating language that might contain, for example, overt or implied attacks on western political institutions, free enterprise, and open regimes for communications and remote sensing.

Unfortunately, it appeared that some of the U.S. delegation gave less concern to the impression it was creating in the process. It might be true to say about UNISPACE'82 what is often said about the United Nations generally -- its most important function is to serve as a forum for discussion and a safety-valve for competing interests. Additionally, such meetings are an important means by which individuals interact, friendships are formed, and critical first impressions and prejudices are established. On occasion during the conference the U.S. let it be known that it was unwilling to compromise or to discuss certain issues. Two examples of this attitude discussed above are: When the U.S. objected to the "concept" of militarization and when the U.S. would not discuss its international programs. This attitude, combined with the already negative impression of U.S.

diplomacy created by other foreign policy decisions, e.g. the decisions not to sign the Moon Treaty or the Law of the Sea Treaty, and the position of the United States on the Siberian pipeline, created a general atmosphere of distrust of U.S. positions and initiatives.

In the future it would be advantageous to conduct such negotiations so as to project to the world the same openness and flexibility that we take for granted in our domestic political institutions. According to members of the U.S. delegation attempts were made to resolve the issues prior to the Conference. When they were not resolved, and were raised at UNISPACE, the U.S. delegation seemed to feel that its only recourse was to "stonewall." U.S. Delegations which have attended international conferences in the recent past have tended to "paper over" or forestall decisions on controversial issues. Such conduct has obscured the fact that significant long-term political trends are developing, for example in communications and remote sensing, trends which are not consonant with presently articulated U.S. interests. Consequently, the United States finds itself increasingly in a defensive mode at international conferences, trying to minimize losses rather than seeking substantial changes to improve its long-term position.

### Effects On Other International Fora

Though UNISPACE'82 itself has no power beyond making recommendations, it may well affect discussions at other meetings which do have the power to make laws or regulations. Many of the foreign delegates that were in attendance at UNISPACE'82 may attend or influence future meetings of the ITU and the Legal Subcommittee of COPUOS. Recommendations in the Conference Report will undoubtedly be used at the ITU Plenipotentiary (Sept-Oct 1982) and future Regional Administrative Radio Conferences (RARC's) to buttress demands for access to GSO, preferential frequency allocations, and technology transfer. Similarly, the work of the legal Subcommittee on COPUOS on the development of principles governing the use of remote sensing and direct broadcast satellites will also be affected by the Conference Report.

It is important to note that unlike UNISPACE'82 where decisions were reached by consensus, decisions taken at the ITU are reached on a "one-nation-one-vote" basis. It is therefore not in the best interests of the United States to allow highly political issues to be decided in the ITU.

## Possible Action By General Assembly

The result of the work of UNISPACE'82 is a conference document, agreed to by consensus, which is some 430 paragraphs in length. As required by the General Assembly resolution which called for the conference (UNGA Res. 33/16 of 10 Nov. 1978), the conference report will be submitted to the General Assembly at its regular session opening in New York on September 21, 1982.

It is difficult to predict in what manner the General Assembly will respond to the Conference Report subsequent to its expected formal approval of it. It is conceivable that the U.N. will take no direct action and that nations will pursue their individual space concerns and needs through existing alliances and institutions. However, it is important to note that the conference report does make a number of significant findings and recommendations which could have an effect on U.S. space interests. Some of the more important are:

**Militarization:** The conference report "strongly recommends" that the competent organs of the United Nations, in particular, the General Assembly and the Committee on Disarmament, should "give appropriate attention and high priority to the grave concern expressed" over the issue of militarization. Due largely to efforts of the U.S. delegation, this was toned down from earlier versions. Should the issue of militarization continue to occupy the attention of the developing world and our close allies it will become increasingly difficult to confine the discussion of this subject to any one forum, such as the Committee on Disarmament. Therefore, representatives of the United States should be prepared to discuss this subject openly in a variety of fora. A continued refusal to do so in the future would likely result in the increased isolation of the United States on this issue and might contribute to serious misunderstanding concerning the historically separate U.S. civilian and military space programs. It could also jeopardize future international cooperation. It is important to note that the ESA charter limits it to purely peaceful activities; the successful characterization of the Shuttle as a weapon could have unfortunate consequences in this regard.

**Geostationary Orbit:** The report states that the GSO and the radio frequency spectrum must be viewed simultaneously, that each is a "limited resource" and that "optimal utilization requires planning and/or arrangements". This somewhat cumbersome language reflects a compromise regarding the disagreement between the United States and the developing nations regarding whether access to GSO and the frequency spectrum should be on the basis of need or on the basis of *a priori* planning. It is unlikely that any action will be taken by the General Assembly as a result of this language; however, it does serve to focus the discussion and to highlight the positions of the respective parties.

The report also calls upon the ITU to "examine the feasibility of incorporating in its future regulations a stipulation that a satellite owner is responsible for removing his satellites from GSO when they are no longer usable". Considering that the United States introduced an initiative at UNISPACE '82 regarding the removal of non-functional satellites from orbit "where practical and feasible", such a proposal should cause little difficulty should it be actively pursued in the ITU.

Remote Sensing: The report recognizes the value of remote sensing technology to the developing countries and recommends:

1) that the United Nations system (FAO, UNESCO, UNDP, UNEP) study user needs and the extent to which these needs can be met.

2) that a study be undertaken to assess the viability of establishing a world-wide, international remote-sensing system.

3) that the Committee on Peaceful Uses of Outer Space (COPUOS) should complete its work on a set of principles governing satellite remote sensing.

If followed, the first of these recommendations should cause little problem for U.S. interests in remote sensing. Such studies would more than likely increase the utilization of Landsat data and would perhaps aid in the difficult process of defining the markets for a commercial remote sensing system. The second recommendation could raise complications depending on what the U.S. decides to do with its land remote sensing system. A decision to transfer this system to the private sector might be in conflict with this recommendation. However, should the decision be made to create a system for remote sensing similar to INTELSAT, then the U.S. might be able to take the lead role in its formation. The last recommendation could raise certain problems for the U.S. Generally it has been the U.S. position that it is unwise to encumber remote sensing with restrictive rules for use. The United States has resisted attempts to formulate a set of international rules governing remote sensing and the sale of remotely sensed data. Should the General Assembly mandate COPUOS to finish its work, or pass strong resolutions on this subject, this could introduce a level of rigidity into the debate and could result in the adoption of principles contrary to U.S. interests.

The report also emphasizes the importance of data continuity.

Direct Broadcast Satellites: While recognizing the value of DBS technology for the delivery of essential services such as education, the report states, "it is essential to bear in mind the need for strict compliance with the applicable plans and other regulatory provisions agreed upon within the ITU". This statement refers in part, to ITU radio regulations which require states "to reduce, to the maximum extent practicable, the radiation over the territory of other countries unless an agreement has been previously reached with such countries". The United States has long advocated that the regulation of DBS be done on a technical basis through the ITU and not on a political basis in other parts of the U.N. system. The language of the conference report refers the problem to the ITU, where, if treated as a technical problem, it will most likely find a resolution suitable to the United States. However, there is also a danger that referring this highly charged question to the ITU may impair the ITU's effectiveness by politicizing what has been a primarily technical forum.

Support for Space Activities: In the course of the preparations for UNISPACE'82, numerous new and expanded responsibilities for the U.N. were debated. In the original versions of the draft report, these coalesced into a proposal to establish a U.N. Center for Outer Space Affairs, which would conduct extensive studies, provide technical assistance to developing countries, and disseminate information. Such a center would have replaced the current U.N. Outer Space Affairs Division (OSAD). This proposal received surprisingly little support from the developing countries during the conference; it was left undecided whether such a center should be established or whether the Outer Space Affairs Division would be expanded.

The U.S. has not opposed a possible U.N. Center or any expansion of the present U.N. functions as long as it does not lead to an overall increase in funding. It should be noted that the establishment of a Center could reduce the influence presently held by the Soviets in the OSAD. However, a U.N. Center dominated by developing countries might be no more friendly to the United States than the present OSAD.

## International Cooperation

In an earlier version of the draft report, strong emphasis was placed on self-reliance by the developing countries; the report urged developing countries to look to other developing nations for technical assistance in space-related projects. Objections to this wording were made on the grounds that this was technically and politically unrealistic and that such urgings implied incorrectly that developing countries could not safely rely on cooperative projects with the West. The final Conference Report does seek to encourage regional cooperation, but on balance does not attempt to persuade the developing countries to avoid cooperation with the developed counties. While it is probably in the interests of the United States to support realistic efforts to develop indigenous scientific and technical capabilities, it should seek to discourage a "go-it-alone" mentality motivated primarily by distrust of developed countries.

## Effect On Private Sector

There is little in the report which could have a direct negative impact on the private sector. Highly controversial paragraphs such as paragraph 150 of the Draft Report which suggested that the developed countries should move their communications systems to a frequency other than 4/6 GHz, and paragraph 306 which suggested that an "international mechanism" should be established to ensure that the benefits of space manufacturing are available to all nations, were deleted from the report with little opposition. This was a positive step.

Although the conference did little damage to the interests of the private sector, it also did little to assure that such damage would not occur in the near future. Issues that are now critical to the U.S. private sector, such as the allocation of frequencies and orbital slots, and issues which may become critical in the near future, such as the imposition of prior consent regimes for direct broadcast satellites and remote sensing have been left largely unresolved. For example, the report states in paragraph 174 on remote sensing: "The sensed state shall have timely and non-discriminatory access under reasonable conditions to the primary data obtained by remote sensing from outer space which relate to its territory." This puts an undefined but potentially serious burden on a private operator of a remote sensing system.

Some members of the U.S. delegation from the private sector and U.S. exhibitors expressed frustration regarding the Conference, feeling that they had not been well utilized. In particular they had been led to believe that their technical expertise would be useful to the U.S., and yet they found almost no technical issues were discussed. Other private sector representatives had more positive feelings about the Conference.

## V

## CONCLUSION

In so far as the U.S. Delegation was able to prevent the adoption of language in the Conference Report which was inimical to U.S. interests, U.S. participation can be regarded as a success. Moreover, although the impact of UNISPACE'82 on the ability of the U.S. to defend its interests at the ITU Plenipotentiary was probably negative, it can be argued that these negative impacts were far less than they might have been. It can also be argued that the overall impact of the language adopted by the Conference regarding militarization of space will be minor. Thus, the U.S. succeeded in greatly limiting any direct damage from the language adopted by the Conference.

General recognition of past United States achievements in space has left a residue of good will which could help with the fact that many United States interests are now different from those of other nations, especially the Group of 77. Unfortunately the lack of preparation and the inflexibility of the U.S. delegation at UNISPACE pictured the United States as unconcerned with the interests of the developing countries. This is distressing in light of the United States' outstanding record of international cooperation, a significant portion of which has been directed to projects with the developing world.

Space technology could be one area in which the United States improves its general position in the "north-south conflict"; it could be a realm of technology where substantial compatibility between U.S. interests (both scientific and economic) and those of developing countries could be found through sincere negotiation. Unfortunately, the events of UNISPACE'82 may not encourage this because the United States' activities tended to focus attention on the areas where there is a divergence of interest between the U.S. and the developing countries, and to suggest that the U.S. has no great desire to seek compromises and common ground.

The historical ability of the United States to reach bilateral agreements with many other countries suggests that both sides are able to avoid posturing when real negotiations are at hand. Typically, agreements on specific programs are hammered out by space program officials of the countries involved. At UNISPACE many delegations where composed of diplomats. Therefore, the U.S. ability to achieve international agreements might not be as adversely affected as one might expect from the negative rhetoric voiced at UNISPACE. Nevertheless, had the United States approached the Conference with a more positive and flexible attitude, more attention could have been given to areas where agreement could be reached, and the overall results might well have been broadly favorable for U.S. interests.

## APPENDIX I
## FORMAL AGENDA OF THE CONFERENCE

1. Opening of the Conference

2. Election of the President

3. Adoption of the rules of procedure

4. Adoption of the agenda

5. Establishment of the Main Committees and organization of work

6. Election of officers other than the President

7. Credentials of representatives to the Conference

   (a) Appointment of the members of the Credentials Committee

   (b) Report of the Credentials Committee

8. General debate (Plenary sessions, mostly presentation of national papers)

9. State of space science and technology (Committee I)

   (a) Review and projection of the current future state of science and technology for space research and applications

   (b) Evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far

10. Applications of space science and technology (Committee II)

    (a) Evaluation of the current and potential applications of space technology, taking into account present and foreseeable national and international programmes in the areas of space research

    (b) Examination of the possibilities and mechanisms for enabling all States to benefit from space technology, bearing in mind their various levels of development, varying capacities to absorb new technologies and particular needs and priorities

(c) Examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard

(d) Examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measures to augment their capabilities to develop space technology and facilitate access to such technology and to participate and cooperate in space activities so as to derive maximum benefit from space technology and its applications

(e) Examination of developments and system configurations appropriate to the use of space technology for education

(f) Discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation

(g) Consideration of the implications of projected developments in the areas of space technology such as earth-orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end

(h) Discussion of the nature of, and ways of protecting, the near-earth environment including the upper atmosphere and magnetosphere

II. International cooperation and the role of the United Nations (Committee III)

(a) Consideration of reports on the nature and extent of the bilateral and multilateral cooperation in outer space activities

(b) Consideration of reports on the activities of the United Nations, including its specialized agencies, and of other international organizations dealing with the exploration and peaceful uses of outer space

(c) Evaluation of the role of the United Nations, its specialized agencies, other international organizations and programmes of bilateral and multilateral cooperation in order to ensure broad international cooperation on an equal basis

(d) Evaluation of the role of the United Nations, in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role

12. Adoption of the report of the Conference

## APPENDIX 2
## ATTENDANCE AT THE CONFERENCE

A. The following (94) States were represented at the Conference.

Albania
Algeria
Angola
Argentina
Australia
Austria
Bangladesh
Belgium
Benin
Bolivia
Brazil
Bulgaria
Byelorussian Soviet Socialist Republic
Canada
Chile
China
Colombia
Costa Rica
Cuba
Cyprus
Czechoslovakia
Democratic Yemen
Denmark
Ecuador
Egypt
Finland
France
Gabon
German Democratic Republic
Germany, Federal Republic Of
Greece
Guatemala
Holy See
Hungary
India
Indonesia
Iran
Iraq
Ireland
Isreal
Italy
Japan
Kenya
Kuwait
Lebanon
Lesotho
Libyan Arab Jamahiriya
Luxembourg
Malaysia
Mali
Mexico
Mongolia
Morocco
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Panama
Peru
Philippines
Poland
Portugal
Qatar
Republic of Korea
Romania
Rwanda
San Marino
Saudi Arabia
Senegal
Somalia
Spain
Sri Lanka
Sudan
Sweden
Switzerland
Syrian Arab Republic
Thailand
Tunisia
Turkey
Uganda
Ukrainian Soviet Socialist Republic
Union of Soviet Socialist Republics
United Kingdom of Great Britian and Northern Ireland
United Republic of Cameroon
United Republic of Tanzania
United States of America
Upper Volta

| | |
|---|---|
| Uruguay | Yugoslavia |
| Venezuela | Zaire |
| Viet Nam | Zimbabwe |

B. The United Nations Council for Namibia was represented at the Conference.

C. The following national liberation movements were represented by observers: African National Congress (South Africa), Pan-Africanist Congress of Albania.

D. Members of the secretariat of the following United Nations offices were present throughout or during part of the Conference:

Centre for Disarmament
Centre for Science and Technology for Development
Department of Political and Security Council Affairs

E. The Secretariat of the Economic Commission of Africa was represented at the Conference:

Economic Commission for Africa

F. The following United Nations bodies and programmes were also represented:

United Nations Development Programme
United Nations Environment Programme
United Nations Industrial Development Organization
United Nations Disaster Relief Organization
United Nations Centre for Human Settlements (HABITAT)

G. Representatives of the following specialized agencies and related organizations participated in the work of the Conference:

Food and Agriculture Organization of the United Nations
United Nations Educational, Scientific and Cultural Organization
International Civil Aviation Organization
World health Organization
World Bank
International Telecommunications Union
World Meteorological Organization
International Atomic Energy Agency

H. The following intergovernmental organizations were represented by observers:

- African Remote Sensing Council
- Agency for Cultural and Technical Cooperation
- Arab Communications Satellite Organization
- Council for Mutual Economic Assistance
- Council of Europe
- European Communities
- European Space Agency
- Intergovernmental Oceanographic Commission
- Interim European Telecommunications Satellite Organizations
- International Maritime Satellite Organization
- International Organization of Space Communications, "INTERSPUTNIK"
- International Telecommunications Satellite Organization
- League of Arab States
- Organization of African Unity
- Pan African Telecommunications Union

I. A large number of concerned nongovernmental organizations in consultative status with the Economic and Social Council were represented by observers.

APPENDIX 3

DEPARTMENT OF STATE
Washington, D.C. 20520

October 9,1981

Dear Mr. Flippo:

Thank you for your letter of September 21 concerning US participation in the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE) to be held in Vienna in August 1982. We share your commitment to the peaceful exploration and utilization of outer space and the principles we have stood for in the United Nations. Our objective is to participate in this conference fully, if the conference is not subverted for Soviet ends and the integrity of the UN personnel system is not damaged.

Starting with the United Nation's decision to hold the Conference, the Soviets have attempted to exert inordinate influence over this meeting, initially by pushing for Moscow as a conference site and later by attempting to subvert the normal UN personnel procedures.

As part of the preparations for UNISPACE, UN Secretary General Waldheim was to name personnel for the Conference Secretariat in late 1980. At that time the position of Chief of the Outer Space Affairs Division (OSAD) in the UN Secretariat had also become vacant. An American, Marvin Robinson, who has served in OSAD for 19 years and who had risen to Deputy Chief of OSAD, was the logical and most qualified candidate for the position. Recognizing that the job of the OSAD Chief was to include the function of Executive Secretary of UNISPACE, the Soviets proposed a Czech space lawyer, with no experience in the OSAD, for that position. Even after strong U.S. opposition the Soviets still proposed that their candidate be appointed as Deputy Chief of OSAD and as Executive Secretary of UNISPACE. Accordingly, in February of this year, NASA's Director of International Affairs, in his capacity as US Representative

The Honorable
Ronnie G. Flippo,
House of Representatives.

to the Scientific and Technical Subcommittee, announced that the US would reassess its commitment to the conference, if someone other than the Chief of the OSAD was appointed as Executive Secretary of UNISPACE.

In March 1981, in a spirit of cooperative compromise, Ambassador Kirkpatrick on behalf of the U.S. accepted a proposal by UNISPACE Secretary General Yash Pal for a compromise candidate to serve as Executive Secretary of the Conference, provided that Robinson would be named Chief of OSAD. To date this package has not been implemented, apparently because of continuing intransigence by the Soviet national who is UN Under Secretary General and who supervises OSAD. An impartial UN reviewing committee has looked into this case of discrimination against Mr. Robinson's candidacy for the OSAD position and supported him.

We are seeking a prompt resolution of this issue at the current UN General Assembly session, along the lines of the Yash Pal compromise personnel package, which has received the public support of many other countries. No country has spoken in opposition to it. But because of the fundamental question of principle raised by the Soviet efforts to undermine the integrity of the UN personnel system, as well as the problems of our nationals in general in the UN, we must insist that these problems be resolved as a condition to our taking part in UNISPACE.

We appreciate your continued interest and counsel on our work at the United Nations in connection with the US space program. I can assure you that we will keep you advised of further developments concerning our participation in UNISPACE.

The same letter is being sent to your colleagues, Representatives Fuqua, Hollenbeck and Winn.

Sincerely,

Richard Fairbanks

Richard Fairbanks
Assistant Secretary
for Congressional Relations

## APPENDIX 4

## UNITED STATES DELEGATION
## TO THE
## SECOND UN CONFERENCE ON THE PEACEFUL USES OF OUTER SPACE
## (UNISPACE'82)

VIENNA, AUSTRIA

AUGUST 9-21, 1982

### Representatives

Honorable James M. Beggs
Administrator
National Aeronautics and Space Administration

### Alternate Representatives

Honorable John R. Bolton
Assistant Administrator for Program and Policy Coordination
Agency for International Development

Honorable Anthony J. Calio
Deputy Administrator
National Oceanic and Atmospheric Administration

Joe Charyk, President and Chief Executive Officer
Communications Satellite Corporation

Mrs. William P. Clark
Washington, D.C.

Honorable Gerald B. Helman
Special Coordinator for UNISPACE
Department of State

Honorable Charles Wick
Director
International Communications Agency

### Congressional Advisers

Honorable Ronnie G. Flippo
U.S. House of Representatives

Honorable William Carney
U.S. House of Representatives

Honorable George E. Brown,Jr.
U.S. House of Representatives

Honorable Daniel K. Akaka
U.S. House of Representatives

Honorable Wayne Grisham
U.S. House of Representatives

## Congressional Staff Advisers

Dr. Radford Byerly, Jr.
Committee on Science and Technology
U.S. House of Representatives

J. Jeffrey Irons
Committee on Science and Technology
U.S. House of Representatives

## Senior Adviser

Honorable Han Mark
Deputy Administrator
National Aeronautics and Space Administration

## Advisers

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Associate Administrator for Space Science and Applications
National Aeronautics and Space Administration

Anna Fisher, M.D.
Astronaut
National Aeronautics and Space Administration

William Fisher, M.D.
Astronaut
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Riccardo Giacconi
Space Telescope Science Institute
Baltimore, Maryland

Henry Hartsfield, Col., USAF
Astronaut
National Aeronautics and Space Administration

S. Neil Hosenball
General Counsel
National Aeronautics and Space Administration

Donald M. Jansky
Associate Administrator
National Telecommunications and Information Administration

J. Edward Melanson, Jr., Captain, USN
National Telecommunications and Information Administration
Department of Commerce

S. Ahmed Meer
Office of Advanced Technology
Bureau of Oceans and International Environmental and Scientific Affairs
Department of State

Kenneth S. Pedersen
Director
International Affairs Division
National Aeronautics and Space Administration

Gilbert Rye, Col., USAF
National Security Council

David Small
Office of the Legal Adviser
Department of State

John H. Storrie, Brig. Gen., USAF
Headquarters
United States Air Force

Norman Terrell
Assistant Director for Nuclear and Weapons Control
U.S. Arms Control and Disarmament Agency

## Private Sector Advisers

Robert Anderson
Chairman of the Board and Chief Executive Officer
Rockwell International Corporation
Pittsburgh, Pennsylvania

Roy A. Anderson
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Henry E. Hockeimer
President
Ford Aerospace and Communications Corporation
Detroit, Michigan

Charles A. Schmidt
Division Vice-President and General Manager
RCA, Astro-Electronics
Princeton, New Jersey

## APPENDIX 5

### Statement of the United States
### Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

by
Honorable James M. Beggs
August 10, 1982

Mr. President:

Twenty-five years into the Space Age, and 14 years after our first United Nations Conference on Outer Space, we again meet in Vienna to consider where we stand and where we are going in the peaceful uses of outer space. The last 25 years have been characterized by extraordinary achievement in space-based activities, not only by the United States but by a growing number of countries throughout the world. Indeed, in a global sense, it is no exaggeration to say that we are on the verge of becoming a space-faring civilization.

The last several decades also have been characterized by United States leadership in space science and applications, frequently exercised in broad cooperation with countries throughout the world. To date, the U.S. has entered into over 1,000 agreements with over 100 countries to share the benefits and adventure of outer space. At the outset of this conference, I want to state categorically that the United States intends to remain the leader in the peaceful uses of outer space and to continue its active and open program of international cooperation.

In this I speak for President Reagan, who is a strong supporter of the United States space program, and its application to bettering our life here on earth. He has asked me to say on his behalf that:

This second United Nations Conference on the Peaceful Uses of Outer Space provides leaders from around the globe with an unprecedented opportunity to chart a course for greater cooperation among nations in exploring mankind's last and endless frontier.

Let us resolve to work together to ensure that the benefits of space continue to contribute to a bright and peaceful future on Earth. And let us also chart new pathways to the stars to serve as avenues of peaceful exploration and adventure for our generation and for generations to come.

Mr. President, in order to assess where we are and where we should be going in space science and applications, it is constructive to reflect on where we have been. When this conference last met in 1968, there were essentially two significant space powers, with a few other countries who aspired to space programs. The United States was in the process of completing its dramatic Apollo project. Twelve Americans walked the surface of the moon during that program and were brought safely back to earth. In the course of this program and in the Skylab program that followed, we established the ability of man to function for extended periods in space and vastly increased our scientific knowledge. Since then, there have been additional important achievements by the United States and by a growing number of other countries in the exploration and peaceful use of outer space.

In the U.S., we have completed the testing of the Space Shuttle and plan to put it into operational service later this year. The Shuttle will give us routine reliable and cost effective transportation into space and will continue to open new and broader areas for international cooperation in the future. We have explored many of the planets in our Solar System and probably will have visited all except distant Pluto by the end of the decade. We have built and flown communications, weather, navigation and remote sensing satellites that bring untold benefits to all the peoples of the Earth.

Since we last assembled in Vienna there have been three particular trends which, taken together, are of special relevance to this conference. Because they will continue, they should be kept in mind as we chart our future course.

-- First, the advance of technology has been rapid and has shown no signs of slowing. Looking back over the short period we have been in space, the rate of progress in amassing scientific knowledge and in applying space technology has been truly astonishing. Consider, for example, the tiny space capsule in which the first American astronaut, John Glenn, orbited the earth. Compare it to the Space Shuttle, launched only two decades later, which is a marvel of sophisticated engineering and promises to be America's primary space transportation system for the balance of this century. The conclusion is inescapable that progress in outer space technology has been dramatic.

-- Second, there are many more nations with space programs today. Scientific, commercial, and technical incentives have led an increasing number of countries to invest their resources in one aspect or another of space technology and applications. These space programs range from large, very complex enterprises to more modest, but nevertheless significant efforts. The United States welcomes this development, the knowledge it generates, and the stimulus it provides to excel in what is still a bright new frontier of human endeavor.

-- Third, there is a growing emphasis on relating space activity to our needs here on earth. Innovators in the private sector are incorporating space-related capabilities into countless areas of human activity.

Looking ahead, we can fully expect these trends to continue. It is clear, then, that among the priority tasks in our agenda of future activities are those which will help us better to understand our own earth; aid in the development of national economies; and assist in the broader sharing of technological skills. The United States stands ready to do its share to achieve these objectives.

## A. Towards a Better Understanding of Earth

Venturing into outer space provides perspectives not only on other worlds; it helps us better perceive, understand and deal with conditions affecting life here on earth. It is clear to the United States, for example, that increased scientific understanding of environmental problems and improved methods in forecasting are needed if we are to enhance our ability to address issues relating to overall global habitability in an effective and efficient manner. We live on a planet characterized by change and it has been demonstrated that space-based observations are of inestimable value in measuring changes which affect the earth. The United States today conducts a number of space-based activities directed towards this end, and we note that other governments and international institutions have also undertaken important efforts in this regard.

We believe it is important to begin to think in larger terms with respect to global conditions. Specifically, we envision continued long-term research efforts with international cooperation to expand further the base of data and knowledge from which sound decisions can be made with respect to the environment. By better organized efforts we can vastly improve the validity and reliability of available information as well as provide more systematic bases for evaluating and responding to long-term global change. Outer space technology will be a more valuable tool in focusing attention on those trends which influence our earth's habitability.

The United States will be discussing a global habitability concept with other governments and international institutions here at the Conference and in the months ahead. We would like to determine whether a more effective, cooperative long-term effort is feasible on a global basis. My government believes such a cooperative undertaking could benefit all countries of the world, developed and developing.

In addition to gaining a better long-term understanding of the earth's environment, the perspective of outer space can help all countries--and particularly developing countries--to better anticipate and cope with natural disasters. To this end, we propose two projects for consideration:

-- First, we suggest that the United Nations Outer Space Division sponsor a working group on disaster assistance communications to examine the possibility of establishing a global emergency space communications system for disaster situations.

-- Second, to learn how best to bring space technology to bear in coping with natural disasters, the United States Agency for International Development will sponsor a five-day conference in the Spring of 1984 in Washington. The conference would examine current operational systems, regional systems being developed, and future technologies applicable to developing a global disaster monitoring and early warning network.

Finally, in order to encourage a better understanding of the earth, the United States is also making available to participants in UNISPACE a special Landsat Index of the best available images collected over the past 10 years by Landsats 1, 2 and 3. The indexes are referenced to the new Worldwide Reference System maps developed by the United States Geological Survey. The data available through the Landsat program is accessible to every country and is indispensable to understanding and employing earth resources for the benefit of mankind.

## B. Assistance in the Development of Economies

Mr. President, there has been a good deal written and spoken about the promise of space technology for national economic development. It is often too easy to give the imagination free play and to ignore the fact that in applying space technology three concepts are fundamental and essential; establishing priorities; allocating scarce resources; and applying the discipline of careful administration. Outer space technology has great promise. And, in its application, much can be done in cooperation with other governments and with the private sector. The process of technology application is not, however, cost free, and should be begun only after deliberate decisions on the part of governments. The United States is prepared to assist in this process through several programs which have proven successful:

-- The United States, through AID's Rural Satellite Program, has begun work with developing countries to advance the use of satellite communications for development. We are carrying out pilot programs in rural telephone and audio-conferencing, providing training, undertaking research and development, and providing information and advice. To share the results of this effort more widely with others, the United States will hold an international conference on rural satellite communications in 1985.

-- The United States will shortly begin field testing a combined low-cost satellite ground station and photovoltaic power system, optimized for developing country use. The results and technical data of this test will be widely available through AID's Rural Satellite Program. This effort is a product of cooperation in research and development between the United States government and industry. Its objective is to lower the cost to developing countries of earth stations and to provide a reliable renewable power source for them.

I invite the Conference to view the U.S.-sponsored demonstrations of this technology in the Seiten Galerie and the Heldenplatz.

## C. Sharing Technological Skills

Mr. President, integral to the success of any of these programs is the spread of the skills necessary to conduct them. The draft report of this conference quite rightly emphasizes the need to expand training programs, particularly for technicians and scientists from developing countries. The United States shares this conviction. Within the context of the work of UNISPACE, and through projects associated with the forthcoming ITU-sponsored World Communications Year, the United States will continue to contribute substantially to training programs and will explore ways of enhancing their quality and availability.

My delegation welcomes the views of others on all of the proposals I have made. We will be prepared to elaborate on these and other ideas in committee and in the scheduled poster sessions.

Mr. President, it is usual in conferences such as UNISPACE to project dramatic future activities and programs. And, I am confident that future developments in outer space will be every bit as dramatic as those which have occured since 1968. I say this because I believe we have the human resources, the imagination, the technical capability, and the determination to accelerate the pace of development in the peaceful uses of outer space.

Space has been aptly named the endless frontier, and looking ahead over the next quarter century and beyond, the potential of exploring and exploiting the space environment for the common good is as limitless as the void of space itself.

I am confident the human family will fulfill that potential. New challenges, new adventure, the resources of new worlds are within our reach. It is up to us to grasp them.

The urge to know the unknown is basic to the pioneering spirit that means so much to the world. That urge is alive and well and will continue to thrive so long as man wants to know. And there is much for us to know.

As T.S. Eliot once wrote: "We shall never cease from exploration and the end of all our exploring will be to arrive at where we started and to know the place for the first time."

In that never-ending quest, the United States pledges to work, in cooperation with all Nations, to bring peace and prosperity to our generation and to future generations inhabiting this planet.

APPENDIX 6

Distr.
LIMITED

A/CONF.101/L.4
20 August 1982

ORIGINAL: ENGLISH

# *Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space*

Vienna, 9-21 August 1982

## Text resulting from the consultations of the "Friends of the President"

1. The extension of an arms race into Outer Space is a matter of grave concern to the international community. It is detrimental to humanity as a whole and therefore should be prevented. All nations, in particular those with major space capabilities, are urged to contribute actively to the goal of preventing an arms race in Outer Space and to refrain from any action contrary to that aim.

2. The maintenance of peace and security in Outer Space is of great importance for international peace and security. The prevention of an arms race and hostilities in Outer Space is an essential condition for the promotion and continuation of international co-operation in the exploration and use of Outer Space for peaceful purposes. In this regard the Conference urges all States to adhere to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies and strictly to observe its letter and spirit.

3. The Conference strongly recommends that the competent organs of the United Nations in particular the General Assembly, and also the Committee on Disarmament when dealing with measures aimed at a prevention of an arms race in Outer Space, in particular those mentioned in the relevant resolutions of the General Assembly, give appropriate attention and high priority to the grave concern expressed above.

LXXXII

Distr.
LIMITED

A/CONF. 101/L.3
20 August 1982
ORIGINAL: ENGLISH

APPENDIX 7

# Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

Vienna, 9-21 August 1982

## Proposal submitted by Mexico on behalf of the Group of 77

## Statement

The Group of 77 firmly holds the view that activities in the field of remote sensing should be carried out in full respect for the sovereign rights of states. The Group of 77 believes that sensed states should have timely and unhindered access on a priority basis at nominal cost, to all data and information obtained over their territories. Dissemination of such data and information derived from it to a third party should not be done without the prior consent of the sensed country. The Group of 77 urges UNISPACE 82 to recommend, through the General Assembly, to the Committee on the Peaceful Uses of Outer Space and its Legal Sub-Committee to finalize the work on the elaboration of draft principles concerning remote sensing of the earth from space as a matter of high priority.

The Group of 77 firmly holds the view that activities in the field of international direct television broadcasting through satellites should only be conducted in full respect for the sovereignty of States. In this regard the recognition by the international community of principles embodying a) broadcasting state's responsibility, b) prior consultation and agreement between broadcasting and receiving states and c) the radio regulations of the ITU, inter-alia, are of utmost importance. The Group of 77 welcomes the text of 16 nations' draft elaborating principles governing the use by states of artificial earth satellites for international direct television broadcasting. The Group of 77 regrets that this draft has not yet met with consensus and that even after ten years of efforts by COPUOS to finalize it have not been successful. The Group of 77 urges UNISPACE 82 to recommend that the General Assembly at its 37th Session approve a set of principles governing the use by states of artificial earth satellites for international direct television broadcasting in accordance with the 16 nations' draft, as aforementioned.

The Group of 77 firmly holds the view that the existing mechanism of the United Nations body dealing with outer space affairs should be strengthened. The Group of 77 urges that the United Nations through its competent organs strongly support programmes and activities of the developing countries and of regional, sub-regional and national interests relating to applications of space technology through training, education, technology transfer and expert technical advice.

# LXXXIII

A/CONF.101/5
13 August 1982

Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

## DECLARATION OF THE GROUP OF 77

Group 77 nations met a few times to discuss some important issues having interconnexion with the over-all activity of the Conference and having bearing on the work of all Committees. The following positions have been arrived at:

(1) Group 77 nations are firmly of the view that the issue of militarization of Space is a matter of great concern. Group 77 nations urge that the Conference recommends that all Member Nations and, especially, those who have the capability, be asked to refrain from any activities which lead to the extension of arms race into Outer Space. Group 77 nations further reiterate that militarization of Space is detrimental to the entire humanity and hence extension of arms race to Outer Space, the moon and other celestial bodies that are the common heritage of mankind, should not be permitted. The position of the Group 77 nations is that testing, stationing and deployment of any weapons in Space should be banned. The Group of 77 considers necessary the adoption of a legal instrument that definitely bans the emplacement of weapons in outer space and verifiable controls and guarantees. In view of their special responsibility in this field, it is recommended that the two major space powers open negociations for an early agreement to prevent an arms race in outer space. Such negotiations should not inhibit or prevent the General Assembly from giving the necessary directives to the Committee on the Peaceful uses of outer space and the Committee on Disarmament for the urgent consideration of this question in conformity with the spirit of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.

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NOTE: As part of the series of special demonstrations connected with UNISPACE 82, the original text of the present document, upon its receipt in Vienna, was relayed via satellite to United Nations Headquarters in New York, where it was translated, typed and subsequently beamed back to Vienna via satellite link.

(2) Group 77 nations are fully convinced that the limited and scarce resources of the GSO and allied radio frequency spectrum should be optimally utilized for the benefit of all countries. Group 77 is of the firm view that the present regulatory mechanism for assigning orbit positions and radio spectrum does not ensure equitable access to this resource, and that developing countries are particularly at a disadvantage. Group 77 is, therefore, of the view that a change to this mechanism is called for. Group 77 notes that WARC-79 of the ITU examined this problem in detail and decided to convene a Special Conference and other Regional Conferences "to guarantee in practice for all countries equitable access" to the said resource and to agree on appropriate planning and other approaches to fulfil this objective. Group 77 considers that the principle of guaranteed and equitable access should be the essence of any new regulatory mechanism and should take into account the particular needs of the developing countries including those of equatorial countries.

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# UNISPACE '82

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WEDNESDAY, JULY 14, 1982

House of Representatives,
Committee on Science and Technology,
Subcommittee on Space Science and Applications,
*Washington, D.C.*

The subcommittee met, pursuant to notice, at 1:09 p.m., in room 2325, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Present: Representatives Flippo, Nelson, Brown, Hollenbeck, McGrath, Winn, and Lowery.

Mr. **Flippo**. The subcommittee will come to order.

Today the subcommittee will conduct hearings on Unispace '82. Next month the U.N. will convene in Vienna the second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Unispace '82.

Several Members of Congress are expected to be named as congressional advisers to the Conference.

For this hearing today, we have invited testimony by witnesses from the United Nations, from the private sector, and from the U.S. delegation. It is obviously getting very close to the time for our delegation to depart for Vienna for the Conference. I have the impression that, despite a rather late and somewhat rocky beginning, the preparations appear to be going about as well as possible at this time.

We would like to hear a description of the status of the U.S. preparation. We want to provide an opportunity for the leaders of the U.S. delegation to explain the issues to be dealt with in the conference, and we would like the views of our other distinguished witnesses. This will give Members of Congress an opportunity, hopefully, to contribute to the process.

Now let me recognize the presence of the ranking minority member, Mr. Hollenbeck, for his opening statement.

Mr. **Hollenbeck**. Thank you, Mr. Chairman.

I join with you in welcoming our distinguished witnesses today.

As we know, Unispace '82 had a rough start in the United States, which I think we will hear about in today's testimony. However, despite numerous organizational delays, we have now successfully rallied a number of corporate exhibitors who will represent the U.S. aerospace effort. Jim Beggs will serve as head to our delegation, and I look forward to his testimony today on the progress that has been made in putting that delegation together.

Unispace '82 is only the second United Nations conference on space, and much has changed since the initial meeting in 1968. A number of different countries have initiated their own space programs, and the European Space Agency, Japan, China, and India have joined this country and the Soviet Union by launching their own expendable space vehicles.

The Unispace Conference is important technically as well as politically. It is our chance to shine in the international aerospace arena by showing the 157 U.N. member nations how they can benefit from U.S.-developed technology.

Many lesser developed countries are extremely interested in remote sensing and communication satellite systems. Direct broadcast satellite systems represent a way in which many of these nations will be able to substantially increase communication capabilities to their people. By utilizing small rooftop antennas, a country can beam educational programs or relay medical information to remote villages that would have otherwise been inaccessible from ground-based system.

Mr. Chairman, I am pleased that the United States is participating in Unispace '82. If we had decided not to go to Vienna next month, the conference could have easily turned into a European and Soviet technology show for the Third World nations.

It is essential that we will be ready to answer both the technical and political issues that most assuredly will arise during the 2-week meeting. These, of course, will include the militarization of space, nuclear power sources in space, prior consent for distribution of remotely sensed data of one's own territory, allocation of the geostationary orbit as a scarce resource, space-related aid to lesser developed countries, and other topics of mutual concern and interest to all U.N. member nations.

I realize, as you stated, Mr. Chairman, there is still a lot of work to do within a very tight timeframe, and I do hope that we will be able to adequately address all of these issues when they will be brought up in Vienna.

Thank you.

Mr. **Flippo**. Thank you.

Mr. Brown, did you have an opening remark?

Mr. **Brown**. Thank you, Mr. Chairman.

I would like to make a few remarks if I may. I have a short statement here, and I would like to read it.

Mr. Chairman, I am very pleased you have called this hearing today on the second U.N. Conference on the Exploration and Peaceful Uses of Outer Space. It is particularly important for us to focus on this Conference in light of the lateness of the U.S. decision to participate. Eight months is not much time to prepare for participation in a major international conference.

My concern specifically involves the perception that the United States will be attempting little more than damage control at Unispace. For a nation such as ours with the greatest space technology and, I have always believed, the greatest vision in the world, I find this attitude distressing.

I hope we hear about U.S. initiatives from our witnesses today who will be part of our delegation going to Vienna.

The President's newly announced national space policy lends particular urgency to our consideration of the U.S. participation in Unispace. The new policy represents a significant departure from current policy, and our delegation must be prepared to respond to inquiries or charges along these lines.

Mr. Chairman, I would like, with the committee's permission, to also include additional material related to the U.S. national space policy with my statement.

Mr. **Flippo**. Without objection, it is so ordered.

[Material included in appendix.]

Mr. **Brown**. Mr. Chairman, let me just add that I think we will come out credibly from this Conference. I think we know that American prestige is at stake and that we have to carry our weight in a conference of this sort. In addition, it is an opportunity, as has been indicated, for the display of American technology.

But I think this is only the first level at which we should be regarding this Conference. It is, in a sense, a great opportunity which I think we are missing by not projecting some of the vision that leaders of our space community have and leaders all around the world have as to the future role of space in human affairs.

I don't think we are going to project that. I don't think we are going to do what I would call a sophisticated marketing operation, which is to actually project systems which will be of tremendous utility to mankind and how we can get to those systems in the next generation, and which is basically a marketing operation which goes beyond marketing in the sense that it would help the whole of mankind to achieve its goals.

Thank you.

Mr. **Flippo**. Thank you, Mr. Brown.

Mr. McGrath.

Mr. **McGrath**. Thank you, Mr. Chairman.

I would like to congratulate you for calling this hearing. I don't believe I can add anything more substantive than what you and my colleagues had to say, so let me suggest that we get underway.

Mr. **Flippo**. Thank you.

I would like to say that we are taking our witnesses in a little different order today. Dr. Jerry Grey will be our first witness. He is the administrator for public policy of the American Institute of Aeronautics and Astronautics. Dr. Grey will be providing us, I believe, with some background on the U.N. purpose of the Conference, and that was one of the reasons we wanted to take your testimony first.

Then we will have Ambassador Wilkowski's testimony. The Ambassador will provide historical background for us based upon her experience at the earlier U.N. Conference on Science and Technology for Development in 1979.

Then, with this information together, our final two witnesses, which we will see together, are the Honorable James Beggs and the Honorable Ambassador Gerald Helman. I think, taken in that order, perhaps it will be more beneficial to the members of the committee, and we would appreciate your indulgence.

Please feel free to summarize as you deem appropriate, and we will, of course, include the entire statement in the record. It is good to have you with us, sir.

[A biographical sketch of Dr. Grey follows:]

February 1, 1982

## BIOGRAPHY BRIEF FOR DR. JERRY GREY

Dr. Jerry Grey received his Bachelor's degree in Mechanical Engineering and his Master's in Engineering Physics from Cornell University; his PhD in Aeronautics and Mathematics from the California Institute of Technology.

His early career included stints as a full-time Instructor of Thermodynamics at Cornell, an engine development engineer at Fairchild, a Senior Engineer at Marquardt, and a hypersonic aerodynamicist at the GALCIT 5-inch Hypersonic Wind Tunnel. He was a professor in Princeton University's Department of Aerospace and Mechanical Sciences for 15 years, where he taught courses in fluid mechanics, propulsion, and nuclear powerplants and served as Director of the Nuclear Propulsion Research Laboratory. He formed the Greyrad Corporation in 1959 and was its full-time President from 1967 to 1971. He is now senior consultant on Public Policy for the American Institute of Aeronautics and Astronautics and Deputy Secretary General of the United Nations Second Conference on the Exploration and Peaceful Uses of Outer Space. He is also Adjunct Professor of Environmental Science at Long Island University, where he teaches courses on energy, Chairman of the Calprobe Corporation, a supplier of high-temperature instrumentation based on Dr. Grey's patents, and a Director of the Applied Solar Energy Corporation.

Dr. Grey is the author of seven books and over two hundred technical papers in the fields of solar energy, fluid dynamics, heat transfer, rocket and aircraft propulsion and power, plasma diagnostics, instrumentation, and the applications of technology. He has served as consultant to the U.S. Congress (as Chairman of the Office of Technology Assessment's Solar Advisory Panel), the United Nations, NASA, the Department of Energy, and the U.S. Air Force, as well as over twenty industrial organizations and laboratories. He was Vice President Publications of the AIAA for five years and Chairman of the Coordinating Committee on Energy of the American Association of Engineering Societies. He is currently Vice President of the International Astronautical Federation, a Director of the American Astronautical Society, a Director of the Scientists Institute for Public Information, and a member of the Explorer's Club. Dr. Grey is listed in Who's Who in America, American Men of Science, Who's Who in Aviation, Engineers of Distinction, Contemporary Authors, and the United Kingdom's Blue Book and Dictionary of International Biography, and is member of the International Academy of Astronautics. His most recent book, Enterprise, was published by William Morrow and Company in 1979; his next book, Beachheads in Space, will be released by MacMillan in 1982.

## STATEMENT OF DR. JERRY GREY, ADMINISTRATOR FOR PUBLIC POLICY, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Dr. GREY. Thank you, Mr. Chairman.

I do appreciate this opportunity to appear before this subcommittee. I appear here today not as administrator of public policy of the AIAA, as I have on many previous occasions, but as the U.S.-designated Deputy Secretary General of Unispace '82. I will be pleased to present, as you suggested, a summary of some of the activities and purposes of Unispace '82.

I want to make clear, however, that any comments I make today are my own personal views and not necessarily those of the Secretary General of Unispace '82 or the Secretary General of the United Nations.

The basic purposes of the Conference, which I have listed in my formal statement, are to discuss and agree upon policies and programs for international cooperation in the peaceful uses of space, to encourage the developing countries to play an increasingly active role in the use of space technology, and to focus global attention on space activities and thereby stimulate wide discussion of their political, social, economic, cultural, and philosophical implications.

The Conference itself was designated by the Committee on the Peaceful Use of Outer Space as concentrating on science and technology, but the committee did note that its discussions should not be limited solely to those subjects. It is expected that Unispace '82 will also cover the implications and the relevance of science and technology to many of mankind's other activities, which again I have detailed in my formal statement.

The agenda itself concentrates on three areas: Space science and technology, the applications of space science and technology, and international cooperation and the role of the United Nations.

The Secretariat which has been appointed is a fine example of a transnational group. Again, I have listed them here in my statement. They are certainly worldwide in their coverage. I might add that I have been pleased to work with this group. We work together very effectively and very well. The preparations for the Conference on the part of the Secretariat are in extremely good hands and in very good condition at the present time. We foresee no major problems although, of course, such problems are likely to come up as time goes on.

In preparing for the Conference, we have received 53 national papers, one of which is a joint paper by 9 of the European Space Agency countries. There have been a number of background papers, books, and statements which will be available to the delegates at the Conference. There has been a newsletter issued bimonthly in order to bring people up to date as to what is happening. The fourth issue of that newsletter is now available, and if you have not received it, I can leave a copy with you here.

We have had regional seminars in a number of places in the world, and special exhibitions. The most recent of these by the Soviet Union, opened just yesterday in New York at United Nations headquarters. There has been an essay contest for schoolchildren all over the world and a poster contest.

I would like to point out that the main Conference itself will be flanked by a number of other activities in Vienna. There is, of course, an exhibit by 29 nations, and I am proud to say that the United States will have a major presence there. I am sure you will hear about that later.

There will be a number of special evening lectures. Arthur Clarke of Sri Lanka will speak; Carl Sagan of the United States of America; and Dr. Oleg Gazenko of the Soviet Union will also present a talk.

There are a number of parallel meetings sponsored by nongovernmental organizations of various levels. A major forum sponsored by the group of nongovernmental organizations will cover some 10 or 12 topics. One of these, on the topic of energy from space, will be a 2-day forum. There is a panel on private industry in space, which will occupy one full day. A major forum will be sponsored by the International Astronautical Federation and the Committee for Space Research. It will be run prior to the Conference in order to acquaint the delegates with the scientific and technical background of the material to be discussed at the Conference.

The formal product of Unispace '82 is the report of the Conference. As you know, a draft report has already been prepared for discussion by the delegates to the Conference. That report is quite extensive. It has some 430 paragraphs, covering a broad spectrum of space activities dealing with the implications of science and technology, the applications of space technology, and some of the activities which might be supported by both the United Nations and those nations who attend the Conference.

There are several subjects which are likely to be dealt with, some issues which will come to awareness at the Conference, which have already been noted in the draft report by the fact that full agreement has not yet been achieved on them. I have itemized them in detail in my statement, and will not dwell on them at length here, but I would like to at least enumerate them for you.

One is the question of the militarization of space. It is not an agenda item for the Conference, but many of the nations have evidenced some concern about the growing use of aggressive activities in space itself. This is in recognition of the fact that many military satellites on both sides of the world are used for extremely important peaceful purposes.

There is some discussion of the reorganization of the United Nations outer space secretariat. I will not dwell on that now. This simply provides a more effective mechanism for developing an expanded and revised program in the Committee on the Peaceful Uses of Outer Space. The four areas that the participating members of the Preparatory Committee that reviewed the draft report felt were appropriate for the Committee on the Peaceful Uses of Outer Space to consider are: A plan to reorient and expand the present program on space applications; a strengthening of cooperative activities with other U.N. units; the setting up of an international space information service; and conducting a number of the studies recommended by the draft report. The proposed reorganization of the United Nations Secretariat would facilitate these activities.

There is some concern about what many countries feel is the growing tendency toward saturation of the geostationary orbit. The developing nations are concerned that they will not have room for their satellites when they are ready to launch them because the developed nations will have filled up all the slots. The developed nations, on the other hand, feel that the growth of technology in this area will provide plenty of room for all. This is a subject that will be debated at length, I am sure, at the Conference.

There are many mechanisms for international cooperation proposed by the draft report. This is, after all, a major purpose of the Conference, and again, some of these concerns are detailed in my statement.

The report calls for an international system for remote sensing. This is a subject that many organizations not only overseas but also within this country feel is an important prospective direction in which to move. There will be a major discussion on setting up a United Nations organization—that is, an organization which might be a part of or an activity of the United Nations—for international remote sensing activities. There is some concern at this on the part of the developed nations who prefer bilateral arrangements of their own type.

In general, the Third World nations support a much stronger role for the United Nations in space. The developed nations prefer to maintain the present level of U.N. activity and to expand cooperation through bilateral agreements.

I do want to point out, however, despite these points of controversy, that we have generated a very extensive report consisting of 430 paragraphs on which agreement has been reached with the exception of only 15 of those paragraphs—a very small amount of contention considering the number and variability of concerns in member nations of the Committee on the Peaceful Use of Outer Space.

Before closing, I would like to say a few words as a U.S. citizen, not necessarily in my role as Deputy Secretary General of the Conference. From the U.S. point of view, I feel that this Conference offers a major opportunity, as Mr. Brown has said, for this Nation to promote its role as a good neighbor and as an important and significant power in the world. It is an opportunity that could cost us very little in the way of actual financial outlay; that is, we do not seek enormous budgets, millions or billions of dollars, in order to achieve this purpose.

We already have many of the capabilities which we can extend to the world and use to cooperate with the world. To make known our intentions to do so, with very little loss financially and with, I believe, very great gain politically, would produce an image of the United States, which I feel we have established in the past, as a member of the community of world nations.

The areas in which we are particularly strong, in which we have things to contribute and in which we might be able to participate most actively in regional, international, and bilateral arrangements are in Earth observations. We have today the only existing civil Earth observation system used worldwide. We can extend its use in a very effective way, I believe, as has been proposed in the draft report, by making it part of an international activity—again, I don't want to say "organization"; that implies some formality—but an international activity which could benefit the world as a whole. This would make a great impression, I believe, on the rest of the world.

In the direct broadcasting satellite area, another point that has been mentioned, we have an opportunity to promote freedom of information in a way that we have never been able to do before. I think we ought to take advantage of this opportunity.

The problem of space debris, although not an important one at this moment, gives us again an opportunity to say to the world, "Here is a concern that in the future will be a real problem to us." We can learn from the environmental consciousness that grew over the last two decades that space is not limitless; it will become polluted with our debris if we are not careful. It is relatively easy to be careful at this point, and the United States has the capability to lead a movement in that direction.

In the area of space manufacturing, although we are not at present the world leader in that field, we had, on our most recent Space Shuttle flight, a very important experiment. It was more than an experiment; it was a prototype space factory for the manufacture of pharmaceutical products. The implications to a world which suffers from medical concerns almost as much as it suffers from those of food shortages is enormous. We could again promote our ability with the Space Shuttle to introduce into the world a major new source of new pharmaceutical products aimed at improving the health of the world's people. I think we need to explore how that integrates into the system, but these are points we could raise.

In worldwide navigation; we already assist in great part with global navigation through our military navigation system. The imminent operational status of the global positioning system offers us an opportunity to greatly expand that, and I think here we ought to make hay wherever possible, indicating that these sources of information, these capabilities, these systems can be utilized in an effective way worldwide.

I do not mean that we should give away our technology, but we can implant these systems into international organizations in an effective way in a manner very parallel to that by which we implanted our communications technology into the International Telecommunications Satellite Organization in such an effective way in the past. I think that organization serves as a model for the way in which we can introduce these U.S. capabilities.

In closing, Mr. Chairman, I would like to say that the United States has a real opportunity here to promote its image as a major supporter of global cooperation, at very little financial cost.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Grey follows:]

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# STATEMENT TO

# SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
# COMMITTEE ON SCIENCE AND TECHNOLOGY
# UNITED STATES HOUSE OF REPRESENTATIVES

ON

# THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE
# (UNISPACE 82)

BY

DR. JERRY GREY
DEPUTY SECRETARY-GENERAL, UNISPACE 82

14 JULY, 1982

UNISPACE 82 SECRETARIAT
ROOM A-555, 866 UNITED NATIONS PLAZA
NEW YORK, N. Y. 10017
212-754-8839

I appreciate the opportunity to present to this Subcommittee my views on the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, or simply UNISPACE 82. Please note that these comments reflect my own personal views as the U. S.-designated Deputy Secretary-General of UNISPACE 82, and are not necessarily those of either the Secretary-General of UNISPACE 82 or the Secretary-General of the United Nations.

The basic purposes of the Conference, which will be held in Vienna, Austria 9-21 August, 1982 are:

- To discuss and agree upon policies and programs for international cooperation in the peaceful uses of space.
- To encourage the developing countries to play an increasingly active role in the use of space technology.
- To focus global attention on space activities and thereby stimulate wide discussion of their political, social, economic, cultural, and philosophical implications.

In pursuing these basic purposes, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) noted that

- "The Conference should not be limited to discussion of science and technology but should also consider their relevance to man and his environment".
- "The...Conference should focus on matters of a global nature ...(such as) regional and economic development, education, communication, resources management, and environment protection".
- "The agenda should be broad enough to...permit discussion of scientific, technical, social, economic, organizational, and other relevant aspects and their interrelationship".

The Conference agenda stipulated by COPUOS focuses on three major areas:

(a) The state of space science and technology

(b) Applications of space science and technology

(c) International cooperation and the role of the United Nations

A transnational secretariat has been appointed to carry out the task of organizing and operating the Conference under the overall cognizance of COPUOS:

Secretary-General: Prof. Yash Pal (India)
Deputy Secretaries-General:
Hubert Bortzmeyer (France)
Dr. Jerry Grey (USA)
Dr. Alla Massevitch (USSR)
Senior Advisers:
Abdel H. Abdel-Ghani (Egypt)
Dr. Peter Bormann (DDR)
Juan J. Tasso (Argentina)
Executive Secretary: N. Jasentuliyana (Sri Lanka)

In preparation for the Conference each member nation of COPUOS was invited to prepare a national paper. Fifty-three such papers have been submitted (one of which is a joint nine-nation European Space Agency paper), and will be made available to the Conference delegates. A volume of background papers on space science, technology, applications, institutions, and related matters was also commissioned for the delegates by COPUOS. These papers were prepared by international teams assembled by appropriate organizations; e.g., the International Astronautical Federation (IAF), the Committee for Space Research (COSPAR) of the International Council of Scientific Unions (ICSU), the World Meteorological Organization (WMO), the International Telecommunications Union (ITU), and others. Regional seminars were held in various parts of the world; special exhibitions by a number of nations were mounted at United Nations headquarters; and an essay contest for school children around the world was conducted, as was a contest to select the most appropriate poster for the Conference.

In addition to the main Conference in Vienna there will be major exhibits by 29 nations and international organizations; a series of live demonstrations to illustrate to the delegates the applications of space technology; special evening lectures by Arthur C. Clarke of Sri Lanka, Dr. Carl Sagan of the USA, Dr. Oleg Gazenko of the Soviet Union, and Dr. Satish Dhawan of India; a scientific and technical forum assembled by the IAF and COSPAR 4-6 August (just preceding the Conference); and a Non-Governmental Organization (NGO) forum on various subjects, to be held concurrent with the Conference.

The formal product of UNISPACE 82 will be its report to the United Nations' General Assembly. Drafts of the report were prepared by the Secretariat and reviewed first by the Conference Advisory Committee (the Scientific and Technical Subcommittee of COPUOS) and then by the Conference Preparatory Committee (COPUOS itself). Copies of the report have been circulated to all members of the United Nations.

Discussion of the draft report, whose organization follows closely the original Conference agenda set up by COPUOS, highlighted a number of key issues. Some of these were resolved by the Preparatory Committee; others will be dealt with at the Conference itself. These issues are summarized below; note, however, that there are a number of major points made in the report which are not identified in my statement, not because they were not important, but simply because they generated little or no controversy.

- Militarization of Space. Although not a specified agenda item (this subject has been referred by the General Assembly to the UN Committee on Disarmament), many nations have expressed concern about increasing levels of military activity in space. Although the draft report does note that many types of military satellites (e.g., for surveillance, navigation, communications, meteorology, etc.) have been operational for years and have value for civil purposes, it states that the current trend toward actively aggressive systems should be reversed. Agreement was not reached by the Preparatory Committee as to how this concern should be addressed in the Conference report.

- Reorganization of the UN Outer Space Secretariat. It had been proposed that the present staff of COPUOS, the Outer Space Affairs Division, be elevated within the UN hierarchy to a Center for Outer Space. The Preparatory Committee recognized this as a possibility, but also noted that some expansion of the activities suggested in the draft report could take place within the present Outer Space Affairs Division. It was agreed that COPUOS would consider (a) a plan to reorient and expand the present Program on Space Applications, (b) strengthening cooperative activities with other United Nations units, (c) setting up an international space information service, and (d) conducting a number of studies recommended by the draft report.

- The Geostationary Orbit. A number of the developing countries are concerned that the geostationary orbit may soon be "saturated" by the satellites of the developed nations, leaving no opportunity for later systems to be emplaced there. The developed nations believe that new technology and the forthcoming use of higher frequencies (Ku and especially Ka band) can provide more than enough capacity to satisfy many times the projected demand growth. The draft report suggests several mechanisms to improve the efficiency of use of the geostationary orbit by both the developed and the developing world.

- Mechanisms for International Cooperation. The draft report recommends that the developing nations cooperate among themselves in preference to cooperating with developed nations. It also stresses multilateral cooperation (regional and global), calling for formal institutionalization of the present global cooperative meteorological program and pointing to the desirability of international remote sensing and navigation systems. The developed nations generally prefer bilateral arrangements.

- Remote Sensing. The draft report calls for an international system, in order to assure continuation of the present data stream and compatibility of present ground equipment with future satellites to be launched by several nations. Again, the developed nations prefer direct bilateral relationships.

In general, the third-world nations support a stronger role for the United Nations space programs, while the developed nations would prefer to maintain the present level of UN avtivity and seek expanded cooperation through bilateral agreements.

Rather than leave with you an impression of controversy, however, I must hasten to note that the unresolved issues involve only 15 paragraphs out of the 430 appearing in the draft report. The report itself, even in its present draft form, constitutes one of the most comprehensive and important documents ever assembled in the interests of global cooperation in space. With the improvements that will undoubtedly be implemented during UNISPACE 82 itself, it offers high promise for a space future that transcends national boundaries, just as space itself transcends terrestrial limitations.

Thank you for the opportunity to present my views on this most important subject. I will be pleased to answer any questions you may wish to ask.

Attachment:

Biography brief, Dr. Jerry Grey

Mr. **Flippo**. Thank you, Dr. Grey. We appreciate very much your illuminating some of these key issues for us.

Let me go to one of the issues. On the radio frequency use, could you place Unispace '82 in the context of the World Administrative Radio Conference and related international meetings?

Dr. **Grey**. Yes, sir. Unispace '82 has no power, nor has it the charge, to introduce new regulations or to effect any changes. The purpose of Unispace '82 is to highlight areas in which cooperation can be promoted.

Now, some of those areas do deal with radio frequency concerns. They are highlighted in the draft report, but not as recommendations of Unispace '82, but merely as points for the International Telecommunications Union to consider. In that context, Unispace '82 can make a contribution but has, in effect, neither the power nor the charge to make such changes.

Mr. **Flippo**. Do you view this Unispace '82 conference and the preparation that we are making for it as a one-shot deal, or do you consider this a part of the ongoing effort; or should there be an ongoing effort on the part of the United States?

Dr. **Grey**. In my personal opinion, I think it should be a peak in an ongoing effort. The United States has had a fairly strong program in international cooperation, mostly a bilateral one, dealing independently with individual nations, but we also cooperate very actively in regional and multinational organizations.

Unispace '82 offers a unique opportunity to crystallize that cooperation—to identify all of the areas in which we are cooperating and to provide a mechanism to increase the level of that cooperation to the benefit of the United States and to the rest of the world.

In other words, in direct answer to your question, there will not be another Unispace '83, '84, '85, '86, I am sure, at least not for a few more years, but if we look at what happened as a result of the first conference in 1968, we will see that it introduced a whole range of new activities, and I would suspect that Unispace '82 will do the same.

Mr. **Flippo**. Mr. Brown.

Mr. **Brown**. Dr. Grey, I appreciated your statement. I wish you were making policy for the United States instead of merely serving in this one Conference.

Do you anticipate anything in the way of concrete results to emerge from this, other than what you have discussed in the form of reports, studies, and so forth? Do you actually foresee, we will say, the crystallization of an organization paralleling something in the earth resources observation field or anything of a similar nature?

Dr. **Grey**. Mr. Brown, I do not see that happening as an immediate consequence, obviously, but what I do see happening is a raising of the consciousness of all of those people who will need to sit down around a conference table and work out the details.

If the United States approaches this program in the right way, the United States can become a major element in such a program, as it was a major element in Intelsat. I think if we do not encourage, or at least support, such activities, we are likely to be left behind those nations which are now in the process of developing a capability which we already have, and I would not like to see our Nation get into that position.

What I am saying is, I don't see a direct result of an international Earth observations organization being formed in 1983. But if the United States participates actively and supports it, there is an opportunity to produce such an organization within the next few years, with the United States playing a major role.

Mr. **Brown**. Will there be initiative from other countries attempting to move along that direction?

Dr. **Grey**. There certainly is an initiative already on the part of the developing nations. Besides there are other nations which have, or will have soon, the capability for such systems: France, the Soviet Union, and the Japanese. They are being a little cautious because we are way out ahead. But when the time comes that they have become either parallel to us or in advance of us, they will be very eager to move into such an organization, to their benefit. They have the model of Intelsat before them, and I think they probably envy our position in Intelsat.

Mr. **Brown**. Well, let's look at the Intelsat model for a moment. That, of course, stemmed out of the creation of Comsat, which was mandated as the U.S. agent for international satellite communication, and I do not recall the exact history leading up to it, but I am aware that Intelsat was structured as a cooperative organization open to any other country in the world and with some rather unique authority, actually, to subsidize telecommunication to the underdeveloped world if it wished to do so. It has the authority to do that. Am I correct in this?

Dr. **Grey**. In general, yes.

Mr. **Brown**. A model of that sort, it seems to me, would be precisely what would be needed and I think would satisfy the Third-World countries who are seeking for broader access to the fruits of this kind of technology.

Dr. **Grey**. Mr. Brown, as you know, a model of that sort has been suggested by the Office of Technology Assessment as a possible prospect. Perhaps a more proper model in today's world might be something more like INMARSAT, the International Maritime Satellite Communications Organization, because it involves the technology of other nations in addition to that of the U.S. Intelsat was based almost wholly, on U.S. technology.

But again, I think the United States should certainly be willing to participate in discussions of such an organization without, at this point, making any commitments; we are not in a position to do so.

Mr. **Brown**. Well, it is my perspective—and I hope it is yours—that we should not take the posture that we are willing to be dragged into a discussion. We should be leading the discussion with a practical, realistic, hard-headed approach to it, but if there is anyone who is capable of pragmatically setting in place such a system, I think it should be the United States.

Dr. **Grey**. Absolutely. Again, Mr. Brown, as an individual, I totally support your point of view. I want to make clear, however, that I am not speaking for the United States or any organization within the United States, administration or Congress, when I say that. But I fully agree. I think the United States is in a position, technically, to lead such an organization, and it would be to our benefit in the long run if we did so.

Mr. BROWN. Thank you, Dr. Grey.

Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

I picked this up, the report of the Office of Technology Assessment. As you know, Mr. Brown and I serve on the board, but we are unaware of the contents of that report, and so I have yet to be able to study that.

I wonder, anywhere in the planning or in the format, has there been given any thought about the discussion on, say, something like a peacekeeping satellite?

Dr. GREY. Mr. Winn, that subject was raised, I believe, in the Committee on Disarmament. It was a proposal by the French. I suspect it will be raised at Unispace '82. It has not come up formally up to this point. It does not appear anywhere in our draft report, but it is a subject, I know, of great interest to many of the nations, and it might very well be raised at Unispace '82.

Mr. WINN. Well, I have written the President a letter asking him to consider that among the many subjects that he and Mr. Brezhnev might discuss this fall, and possibly if that subject matter could be discussed pretty thoroughly at the Unispace '82, then there might be some additional information that could be sent to both the President and taken by the Russians to Mr. Brezhnev.

The reason I am sort of stymied here on the question is that I don't know what the French discussion was.

Dr. GREY. The French simply raised the proposal in the Committee on Disarmament, and the details of that I do not know myself. I have not been involved with that subject myself, personally but if there is a mechanism by which it can be raised at Unispace '82, and if you are interested in doing so, I think it would be of interest if you were to explore that, sir.

Mr. WINN. I think we might, from the committee, make a suggestion along that line. It would give our delegation a chance to have some so-called authority behind them.

Dr. GREY. Perhaps you would like to raise that question with Mr. Beggs and Mr. Helman when they appear later before this committee. It is a subject that is beyond my coverage in my capacity as Deputy Secretary General.

Mr. WINN. Thank you very much.

Thank you, Mr. Chairman.

Mr. BROWN. Mr. McGrath.

Mr. MCGRATH. Thank you, Mr. Chairman.

Dr. Grey, can you tell us of any of the initiatives of any of the other countries participating this Conference?

Dr. GREY. I have not yet received any of these at the secretariat, Mr. McGrath. The initiatives will be proposed at Unispace '82. In fact—I will be honest—I don't know what initiatives the United States is going to propose at this point, and I have not yet heard from any of the other nations.

Mr. MCGRATH. Maybe Mr. Beggs can tell us.

You referred to an international system for remote sensing. What did you have in mind in talking about that?

Dr. **Grey**. There have been a number of proposals raised in this connection. As I say, the Office of Technology Assessment had proposed four or five different models suggested in the previous OTA report—not the one that Mr. Winn has on his desk, but the one on space applications which you received previously.

There are any number of possibilities. It could be an organization paralleled after Intelsat, for example, where a formal organization is set up to both manufacture and launch satellites and to generate a mechanism whereby individual nations can build and use their own ground stations in connection with the space segment. There could be simply a pooling of resources, as we now do in the meteorological field, where the manufacturing country owns and operates its own satellite but makes the data available on some sort of an organized basis to the rest of the world. There are any number of possible alternatives in between.

I believe it is necessary to sit down in an international forum and discuss these various mechanisms and see which ones evolve as being the most effective. But I would like to see the United States take a leading role in promoting such an activity, because I believe that since we do currently have the lead in this technology, we are in a position to benefit most from it. If we wait too long, there are other nations and other organizations which will take over that lead, as they look like they are about to do.

Mr. **McGrath**. You mentioned that the United States is not the world leader in space manufacturing. Who is?

Dr. **Grey**. I don't know if there is a world leader. All I can say is we have not had any in-space experimental work since Apollo-Soyuz, except for our sounding rocket experimental work. On the other hand, extensive sounding rocket experimental studies have been done by the Germans. The Russians, in their Salyut space station, have done a considerable number of experiments, whose details I am unfamiliar with, but they speak about them as being extensive. So I strongly suspect that, at the moment, we are probably not the leaders in space manufacturing. I am hoping that with the operational status of the shuttle, Spacelab coming up in the near future, and experiments such as the electrophoresis experiment on the last shuttle, that we will very soon take that position.

Mr. **McGrath**. I have no further questions.

Mr. **Flippo**. Thank you very much.

Dr. Grey, thank you so much for your testimony. It will be very helpful to us.

Mr. **Flippo**. Our next witness will be Hon. Jean Wilkowski, former U.S. Ambassador.

Mr. **Brown**. Mr. Chairman, before Ambassador Wilkowski speaks, could I ask permission to insert, at the discretion of the staff, all or part of the French report on the implications of establishing an international satellite monitoring agency, which was referred to by the gentleman from Kansas.

Mr. **Flippo**. Without objection, it is so ordered.

[Material included in appendix.]

Mr. **Flippo**. We are delighted to have you with us. Please feel free to summarize as you deem appropriate, and we will, of course, include the entire statement in the record.

## STATEMENT OF HON. JEAN WILKOWSKI, U.S. AMBASSADOR AND COORDINATOR FOR THE U.N. CONFERENCE ON SCIENCE AND TECHNOLOGY

Ambassador WILKOWSKI. Thank you, Mr. Chairman.

I am flattered and grateful to be here for the opportunity which you and the subcommittee have afforded me to testify at this hearing on Unispace '82 to be held in Vienna in Austria in mid-August of this year.

I am particularly happy to see so many old friends here who were very supportive of U.S. preparations for the U.N. Science and Technology Conference or UNCSTD in 1977-79.

May I assure you, Mr. Chairman, I have a sustained interest in conference diplomacy and in the specific issues and opportunities which are afforded by Unispace '82. This relates to my previous experience as the U.S. coordinator for UNCSTD and to my present position as chairman of the board of Volunteers in Technical Assistance, or VITA.

VITA is a private voluntary organization interested, among other things, in space science and technology.

I believe that Unispace '82 provides the United States with a major opportunity, as was indicated by the previous speaker, an opportunity to declare its extraordinary accomplishments as well as potential in the field of space science and technology. I think it is important that there be strong backing, both from the legislative and the executive branches of the U.S. Government, as well as from the private sector for the purposes and objectives of Unispace '82 so that the United States can play its rightful role as a leader at this Conference.

I wish Unispace '82 every success so that all participating United Nations member states might benefit and develop as a result.

In my detailed written statement, I have tried to elaborate on two separate, but not totally unrelated, themes. The first covers some of the lessons learned by the United States from preparing for and participating in the U.N. Conference on Science and Technology for Development.

The second describes the particular interest of VITA to collaborate with other elements of the U.S. private sector, with the U.S. Government, with developing country governments, and with international institutions on followup to Unispace '82.

However much we may despair at times of efforts at the United Nations to promote economic progress and keep the peace, I believe we have no institutional alternative on this planet for seeking multilateral solutions to such pressing global issues as trade, debt, development, food, energy, and science and technology, including space.

There is no single country, nor any two countries, in the world today which can attempt to settle or agree on any aspects of these global problems. They concern all countries. Multilateral diplomacy has become a necessity of our age, and international conferences will remain one of the most important diplomatic challenges of the eighties.

The United States must build on its experience and lessons learned in conference diplomacy of the seventies, and it must improve on its performance so as to further its own national interests and take advantage of the opportunities which these conferences present.

One such opportunity is the maintenance of a responsible and nonconfrontational dialog between the industrialized countries of the North and the developing countries of the South. The developing countries are far too important to U.S. investment and trade to ignore their special interests in multilateral diplomacy and the opportunity which these conferences offer them for greater unity and strength as well as the promotion of their own national interests.

Now, there are many private voluntary organizations, or PVO's, in the United States whose main purpose is to offer assistance to the developing countries of the world. VITA, for Volunteers in Technical Assistance, is one of these. It was organized by a group of scientists and businessmen and engineers over 22 years ago. It has since grown into a very important development system. It is based on a roster of nearly 4,000 volunteers, experts in their fields, not just from the United States but volunteers from all over the world. We even have volunteers in China now.

These volunteers, through mail or direct consultancy, provide information to people with technology questions and hopes in developing countries. Their problems range over food, energy, housing, and enterprise development, but most importantly, in the technology of information transfer. This last subject—technology of information transfer—is taking VITA into the realm of microcomputer based information systems and into space with the use of remote sensing satellites.

VITA has an important documentation center and a data base covering over 800 technologies and 40,000 cases. This information needs fast and accurate transmission to end users in developing countries. We are hopeful that the results will provide us with new opportunities.

Currently, VITA is engaged in developing an appropriate response to a large U.S. multinational corporation which wants to bring the benefits of its sophisticated high technology in information and communications to villagers in the Third World. VITA believes that with the help of its expert volunteers, a number of whom are space scientists, it can design a program which will help train and educate villagers and transfer needed technology for village use by satellite as well as by traditional communication modes.

VITA is thus one of a number of institutions in the U.S. private sector which is interested in a successful Unispace '82 conference. Success must take account of the needs of the developing countries in applications of space technology, which is one of the key agenda items of Unispace '82.

My prepared statement, which I have submitted for the record, provides greater detail on these two general themes of lessons in conference diplomacy and ways in which one private voluntary organization can contribute to implementation of the results of a successful Unispace '82 Conference.

Before I thank you, Mr. Chairman, and express my willingness to take questions, I would like to review some of the activities of VITA relevant to the purposes of this hearing. As I understood they were three: to acquaint Members of the Congress with the issues that will likely be discussed; of Unispace '82; to provide the U.S. delegation with an opportunity to describe preparations for the Conference; and to better equip congressional advisers to deal with policy resulting from Unispace '82.

For over a year, VITA has sponsored about 20 teleconferences over the peace satellite to the Pacific islands on new and renewable energy. VITA is also actively pursuing the possibility of collaborating with a multinational corporation to provide microcomputer training programs and staff to an appropriate technology center in east Africa, with the eventual possibility of some space link.

VITA has an interest as well in linking its international technical inquiry service with any world science and technology information network which might result from Unispace '82. I am hoping, that this hearing will tell us something of the initiatives which the U.S. delegation proposes to take at the Conference.

VITA is also considering the feasibility of using low-cost microprocessor-based image analysis systems to produce maps for LDC's that integrate different sources of remotely sensed information, including Landsat subscenes.

Before I conclude, I want to express pleasure at the wisdom of the administration in appointing Ambassador Helman to coordinate U.S. preparations. Ambassador Helman is a self-starter. He is an old hand and real professional at multilateral diplomacy. I think he will be able to do in very short order what it took some of us with less experience longer to accomplish when we prepared for UNCSTD.

With that, Mr. Chairman, I would be happy to take questions from the committee.

Thank you.

[The prepared statement of Ambassador Wilkowski follows:]

### PREPARED STATEMENT OF AMBASSADOR WILKOWSKI

Mr. Chairman and members of the committee, I want to thank you for inviting me to testify on the subject of U.S. preparations for the United Nations Conference called Unispace '82.

While I have not followed Unispace '82 preparations directly I am familiar with some of the issues and also with what is required for successful conference diplomacy.

My interest in the issue of space science and technology derives both from my work as U.S. Coordinator for the 1979 United Nations Conference on Science and Technology for Development ("UNCSTD") and my present position as chairman of Volunteers in Technical Assistance ("VITA"). VITA is a 22-year-old private voluntary organization established by scientists, engineers and businessmen dedicated to improving the lives of disadvantaged people in developing countries through technology transfer.

As I understand, the purposes of this hearing are three: (1) to acquaint members of Congress with issues that will likely be discussed at the conference; (2) to provide the U.S. delegation with an opportunity to describe preparations leading up to the conference; and (3) to better equip Congressional advisors to deal with policy resulting from Unispace '82.

As regards the issues, I shall address only those of interest to VITA which is now in the process of analyzing how it might draw upon its expert volunteer resources to design proposals on more sophisticated technology of information transfer and use of microcomputers in developing countries. This study is at the request of a major U.S. multinational corporation which asked VITA to serve as an intermediary between the corporation's sophisticated high technology and technology suitable at the village level.

For over a year VITA has sponsored about 20 teleconferences over the Peacesat to the Pacific Islands on new and renewable energy topics of interest to island governments and community development organizations. Feedback from these teleconferences to date has been very positive. VITA staff and volunteers provide the technical information for these conferences and VITA headquarters provides pre-conference and followup documentation to support the information transmitted by Peacesat.

VITA is also actively pursuing the possibility of collaborating with the same U.S. multinational corporation to provide microcomputer training programs and staff to an appropriate technology center in East Africa with the eventual possibility of some space link.

VITA has an interest as well in linking its international technical inquiry service with any "World Science and Technology Information Network" which might result from Unispace '82.

VITA interests extend further to the possibility of providing technical and biological/agricultural information to less developed countries ("LDC") by means of direct satellite communications links with ground stations in LDCs.

VITA is also considering the feasibility of using low cost microprocessor based image analysis systems to produce maps for LDCs that integrate different sources of remotely sensed information (including Landsat subscenes).

All of these concepts currently under design at VITA are related in one way or another to issues on the Unispace '82 agenda.

As regards the second purpose of these hearings—to hear how U.S. preparations for Unispace '82 are going, I can contribute very little from my present position outside the Department of State. But I can comment on the wisdom and excellent judgment of the Department and this administration in naming Ambassador Gerald B. Helman to coordinate Unispace '82. Ambassador Helman is an expert in multilateral affairs and negotiations, of which we have all too few in our service. He has held one of the three most responsible assignments in the area as U.S. representative at the U.S. Mission in Geneva where the main business has always been international conference and United Nations work. He has also served with distinction both at the U.S. Mission to the UN at New York and in policy positions in the Department's Bureau of International Organizations. I can think of no more qualified person to lead Unispace preparations. Ambassador Helman knows how to work quickly and well in the confusing and often frustrating atmosphere of the UN, and he knows how to use the many instruments of the UN system to promote U.S. foreign policy interests.

Concerning the third purpose of these hearings—to better equip Congressional advisers to deal with policy resulting from Unispace '82, my own experience in conference diplomacy and views I hold on the United Nations may be relevant.

Americans generally tend to be skeptical about the UN and what UN conferences can accomplish. Are they worth the considerable effort and cost attached to them? Do countries really heed the results? Are these conferences just make-work for the army of international civil servants at the United Nations? These doubts are quite real and they bear testing.

Of fundamental importance to the success of any UN conference on global issues is a firm belief in the United Nations and its mission, and that something useful can come out of UN conference.

Much of the criticism of the United Nations is based on lack of knowledge and understanding of what the United Nations stands for, has done and can accomplish. For example, we cannot ignore the UN on the Middle East question and then turn to it to solve the issue of disarmament. This is on-and-off diplomacy—taking matters to the UN when it suits the convenience of certain countries at certain times, and ignoring it at other times.

One of the strengths of the UN is precisely that its structure and ideology are democratic, even when its membership is not. Ismat Kattani, an American-educated Iraqi and now Secretary General of the UN General Assembly, speaking a few weeks ago in Washington at the local chapter of the World Affairs Council, said that had the UN not been created in 1945 and had it been created for the same purposes today with over 150 nations instead of the original 45, it might be far less democratic in structure and ideology than it actually is. Thanks to American influence in creating the UN, the institution does rest upon democratic assumptions. This is a hidden advantage to our country in its participation in UN work and in conferences like Unispace '82.

Kattani also said that nothing really important happens at the UN without the U.S. playing a leading role. I would hope this is the position the U.S. will take for its participation in Unispace '82.

Allow me now to review some of the major considerations which must be dealt with in preparations for any UN conference. I will draw on two recent studies on the subject: the first, a Handbook for U.S. Preparation in Multilateral Diplomacy prepared for the Department of State, which was inspired during preparation for UNCSTD. The study was done by the Futures Group of Glastonbury, Connecticut, in September, 1981. The second is a case study on conference diplomacy covering UNCSTD which was done for the Institute of Diplomacy of Georgetown University.

UNCSTD was the last in a series of conferences in the Seventies which dealt with global issues in the North-South dialogue, issues that deeply concern both the industrialized countries of the North and the developing countries of the South. But it was not the last of such conferences.

Unispace '82 follows in this tradition and will be confronted with many of the same ideological questions and economic objectives of UNCSTD. These concern the basic demands of the developing countries for a New International Economic Order ("NIEO") seeking a greater transfer of resources from rich to poor countries. Discussions of the NIEO have been led by the so-called Group of 77, a developing country caucus with over 120 members. They have ranged over such economic issues as trade, debt, and development, and such sectoral issues as food, energy, science and technology. Issues, like capacity building, information networks, research and development, and transfer of technology, which surfaced at UNCSTD, appear to be resurfacing again at Unispace '82.

UN conferences on global issues are a fact of life in today's diplomacy and it takes experienced, hard-headed professionals to prepare for them and to negotiate them. Yet these conferences can present important opportunities for US diplomacy. These range across shaping a reasonable accommodation on developing country desires; striving for a cooperative approach to global problems; and achieving specific diplomatic and commercial advantage vis-a-vis our commercial competitors in these instances in which developing country demands and U.S. interests and capabilities coincide.paration

However strong the temptation of industrialized countries to balk at new demands from developing countries for resource transfers and other concessions, it should be resisted. The countries of the South are too important as major markets for U.S. raw materials and capital goods exports, as well as important suppliers of energy, minerals and manufactured foods and substantial borrowers from U.S. commercial banks. The United States has become intimately linked with these countries not only through trade and investment, but through ever increasing exchange of people, especially immigration, both legal and illegal.

For all these reasons the U.S. must accept the inevitability of conferences, draw on its institutional memory and employ its best diplomatic experience and skills so that these conferences can be used ot serve U.S. national interests.

Certain lessons were learned from our participation in UNCSTD which might be useful to those working on Unispace '82 and other international conferences. These fall into three major areas for improvement.

The first is the need for better integration of U.S. conference diplomacy with overall U.S. foreign policy. In the case of UNCSTD, the policy governing our preparations and stance at Vienna was not as convincing as it might have been were there a clearer and more coherent structural and framework for U.S. foreign policy toward the Third World. For example, our general policy statements spoke of the need for increased (but not massive) resource transfer. Yet we had great difficulty in translating this into specific initiatives which had both a good chance of survival through the domestic legislative process and general acceptability by developing countries.

Our policy promised more than it could deliver, partly because the American public had not been adequately educated by the Government and media to understand the full importance of the Third World in our economic and political life. Also, there has been serious erosion in public support for foreign assistance. The proposal of a previous Administration for unilateral establishment of an Institute for Scientific and Technological Cooperation ("ISTC") was authorized but failed for lack of funding. It thus became much more difficult to sell the Congress on the idea of a multilateral funding organization at the United Nations which had similar, but not the same objectives. And without a full-time official completely familiar with the entire UNCSTD process and negotiation to follow up on the U.S. commitment at Vienna for such a fund, its chances of Congressional support were greatly lessened.

The overall U.S. foreign policy unbrella must be sharply and realistically articulated and offer a good fit for the more specific U.S. objectives for any global conference. Clear congruity between conference results and U.S. policy makes it easier to obtain the necessary executive branch and Congressional approval.

A second area for possible improvement in our traditional conference diplomacy is the preparatory process. U.S. preparations for UNCSTD scored reasonably well on this point. There were structured consultations with the Congress, indeed at least six general briefings and hearings, as well as individual encounters with the Coordinator and Delegation Chairman. There was Congressional interest and participation in Preparatory Committee meetings at New York and Geneva and there were extensive consultations with the private sector involving several hundred U.S. corporations, foundations, universities and institutions. The resulting analytic studies were a helpful guide to initiatives and strategies in the U.S. position for UNCSTD and would not have been possible without the foresight of Congressional authorization of funds to the National Science Foundation.

Considerable technical help and political guidance for UNCSTD preparations was provided by an eminent group of senior advisers from in and out of the government who were brought together by the chairman of the U.S. delegation to Vienna, Father Theodore M. Hesburgh, President of the University of Notre Dame. Called the Hesburgh Steering Committee, the group met quarterly at the Undersecretary level in the Department of State.

While there were some problems in briefing non-governmental organizations ("NGO") these derived mostly from their great numbers and variety, given the breadth of the subject of science and technology, and the disinclination of any individuals or groups to represent the whole. But a mutually satisfactory solution to this communication problem was reached between the U.S. negotiators and the NGO representatives during the final two-week session at Vienna.

Interagency consultation for UNCSTD was generally good, especially as a result of the Presidential Review Memorandum process initiated by the National Security Council and implemented at a high policy level in the Department of State. There were bilateral U.S. consultations in Asia, Latin America, Africa and Western Europe. The results were mixed because of the complexity of the subject and the delays and drift in G-77 articulation of a basic negotiating position. Bureaucratic support for the U.S. Coordinator's office was generally good, but the quality was affected by the lact of clarity in U.S. policy, and the low priority given to Third World affairs and international organizations, mentioned above.

The third area which analysts have cited for improvement in the traditional U.S. approach to global conferences is in the quality of our multilateral diplomacy. The U.S. coordinating work for UNCSTD was headed by senior diplomats with multilateral experience and supported in the final session by two professional negotiators with considerable diplomatic experience at the United Nations. Unispace '82 should enjoy even higher marks under the leadership of Ambassador Helman because he brings extensive UN experience to the process from the outset.

As regards Congressional interest and support for UN conferences, I think the best advice is to seek it early, sustain it through the preparatory process and the final negotiating session, and to work very hard with Congressional leadership in the follow-up process to insure that the conference results become a reality. As indicated earlier, UNCSTD may have provided a good example of liasion with Congress up through the final negotiating stage at Vienna, but it broke down in the post-conference follow-up stage.

The U.S. delegation to UNCSTD carried 22 Congressional members of a total delegation of 68, an unusually large—perhaps too large—delegation. Usually a role definition problem characterizes Congressional participation in U.S. delegations to global conferences. The U.S. Congressional delegation to UNCSTD participated in useful but short (2-3 days) discussions with key delegations, impressing on them the extent of U.S. foreign assistance already provided in the area of science and technology for developing countries, and cautioning moderation in LDC demands for new institutions and funding.

However, the sheer size of the U.S. delegation and the prominence of the individual participants, including the Congressional segment, gave rise to certain LDC expectations which, as indicated, were not completely fulfilled. Thus, a careful balance must be drawn by U.S. diplomatic leaders between likely benefits of going to a conference with a highly visible and impressive delegation as a substitute for a reliable policy, or going with a delegation more modestly pitched which better reflects the realities and limitations of U.S. policy.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you very much, Ambassador Wilkowski.

How did Third World nations of the rest of the world view the conference in 1979 in terms of political versus technical?

Ambassador Wilkowski. The LDC's considered it primarily a political confrontation, more than an opportunity to get into the substance of science and technology. There was an effort, it is true, on the part of some of the countries in hopes that we could get them to focus on specific projects in food and energy and health, but I think they saw it largely as an attempt to further their objectives under the new international economic order, and it was a question, I think, of more power, more authority within the United Nations system that was basically at the root of their objectives. It took us a little while to discern this.

Mr. Flippo. And, discerning that, how did you prepare for that in the 1979 Conference? How did you prepare for the political side of that Conference? Did you involve the private sector? How did you approach that?

Ambassador Wilkowski. Well, in my prepared statement and also in a study which I did for Georgetown University, a case study on conference diplomacy, I pointed out that our political framework was not necessarily as strong as it might have been, but on the technical side, I think we were quite strong at Vienna because we engaged in what I think was perhaps the most extensive outreach program of any previous conference, going out to the private sector, going out to the science community, the business community, the PVO community. We had well over 200 American corporations engaged in research and analysis and policy recommendations for us. We had strong support from the National Academy of Sciences, the National Academy of Engineering, from private consultants as well, and we carried on discussions and dialog domestically in various cities in the United States trying to help us define our position for this Conference.

Mr. Flippo. Mr. Brown.

Mr. Brown. Ambassador Wilkowski, you, in your prepared statement, have gone into considerably more detail as to the preparations for the 1979 conference, and it does seem to have, if not been a model, at least been a very good example of an effort, make broad-based preparation for an international conference.

As you have indicated, the weakness was in the political framework, the enunciation and followthrough on policies that were an important part. Could you—I know this is not a fair question—indicate how you perceive the preparations for this Conference in comparison with the 1979 conference, both as to the technical involvement and preparation and the political framework?

Ambassador Wilkowski. As I indicated, Congressman Brown, in my prepared statement, my vision is from outside the Department of State these days. I do know that they do have shorter lead time. I do not know the reasons for that.

But I am confident that a man of Ambassador Helman's experience, with the support of the administration, the bureaucracy, should have a little easier time. You see, our problem with UNCSTD was that it was so broad, it was like a huge jellyfish, you know—what is science and technology? What part of it, the policy of it, the research and information?

This Conference, Unispace '82, seems to be a little better focused, a little better defined, but I must say, I have not followed the preparations in detail, either as an active person involved in it or even from the outside. So it is very hard to make these comparisons.

I just know that they have a very short lead time, and I would have been uncomfortable with that little time had I been told there were 8 months to get ready for such a poorly defined conference as was UNCST.

Mr. **Brown**. Well, obviously, it helps a great deal to have an experienced, capable person in charge. We thought that in 1979.

Ambassador **Wilkowski**. Thank you.

Mr. **Brown**. But that does not solve the lack of adequate political focus, as you well recognize from your own comments as to the lack of followthrough on some of the commitments, or semicommitments, at least, that were made at UNCSTD.

Ambassador **Wilkowski**. You are right, Congressman Brown. This whole question of conference diplomacy has been studied very carefully by a group at the State Department, and I am happy to say that, because we were so frustrated in our preparations—no Conference is easy. It never rolls off smoothly like some homogeneous product. It goes in several different directions at once, and the big job of the coordinator is to give some shape at least to the U.S. position and to keep it on track.

It is not a very easy thing to do, but in this study, which as I said, I am very happy to say, came out because of the frustrations we had, but we now have in the Department of State, after all these years, all the conferences we had in the seventies, we now have this handbook for U.S. participation in multilateral diplomacy. It analyzes, with the help of such old pros as Ambassador Yost, Ambassador Ed Martin, who all contributed to it, and one of the great weaknesses, they say, and the area for greatest improvement is to have this good link, this good integration between an overall policy framework and the particular conference.

Since Unispace '82 will be both technical and substantive as well as political—the proportions I cannot even attempt to assign—but it will have this very important political component because it is an ongoing part of the North-South dialog, my concern is about the overall framework, as it was in UNCSTD, the overall political framework of U.S. policy toward the Third World and the kind of fit that our policy and strategy for Unispace '82 has with that major foreign policy umbrella.

Mr. **Brown**. Well, I share that concern very strongly.

Mr. **Flippo**. Mr. Winn.

Mr. **Winn**. Thank you, Mr. Chairman.

Ambassador Wilkowski, I think I know what you are saying, and I do not disagree with you on the preparation. At the same time, early on, it is my understanding—and maybe Mr. Beggs or someone else can correct me if I am wrong—that this administration did not know how strongly it wanted to participate in the Unispace '82. Had you ever heard that?

Ambassador **Wilkowski**. No, I had not, sir. I have had some discussions with Ambassador Helman but largely related, as I indicated, to our interest in VITA and the followthrough. I think you would have to inquire of the administration witnesses on that point.

Mr. **Winn**. All right.

Second, I think it is also a pretty well-known fact that they are having some trouble getting their team put together because of vacation schedules, because of elections, because of whatever reasons, and that might also, of course, add to the fact that their naming of the delegation is slow and dragging and thereby making it difficult to do any long-range planning when they do not have the people in place.

I am not defending that; I am just pointing out some of the problems that I am well aware of. Several members of this committee would like to go and would like to participate and have been invited to do so, but because of elections, I suppose, mainly, and other problems, they are not able to go.

Is there, in your opinion, based on your experience, any one main focus point, direction, that you would like to see the U.S. delegation head for or try to accomplish?

Ambassador **WILKOWSKI**. Well, I would hope, sir, that Unispace '82 could continue from the point where we left off at UNCSTD.

As you may know, we mounted what we thought was an excellent exhibit on remote sensing, an earth satellite, resources for development. Unfortunately, the exhibits at Vienna were not as well located as they might have been, and the attendance was not as good. As I understand, there will be a better link here at the Unispace Conference.

But I would like to see those same themes played on because I do not feel there is enough understanding in developing countries about what remote sensing is all about. When I was Ambassador in Zambia, I tried very hard to impress upon the Zambians the particular potential for developing countries, and ultimately they did build an earth station to link up with the international communications satellite, but there is a dearth of understanding in the most elementary terms among many of the developing countries.

As we talked in our preparations for UNCSTD, you cannot look upon the developing world as a homogenous mass. You've got to categorize these countries, and you've got to make pitches for all of the different levels of development of the developing countries.

I would like to see a continuation, yes, of this same kind of exhibit we had and have it reaching more people and have the message better understood.

Mr. **WINN**. Hasn't that been one of the problems of the United States for many years—that we tried to develop what we think other countries, particularly the lesser developed countries or the Third World countries, should have and should do, probably politically, to make ourselves look good, to make us look friendly, to make us look like we are trying to be helpful? And in many cases we are so far ahead of them, they don't know what we are talking about, and then it becomes a political issue of, are we trying to buy them off one way or the other? That is probably a poor usage of the word, but I think that is really what I mean, so that we can get them to side with us and we develop a friendship with certain countries which we have doubts about at the present time.

If we try to take some of these proven technologies that we have proven to ourselves and that we know work, and they don't know how to cope with that, it might be like throwing a ball to somebody that doesn't know what a ball is, does not know it is to be caught.

Ambassador WILKOWSKI. I think you are quite right. I think that does happen. I think you have got two phenomena here. I think you have a situation sometimes where we may act as though Uncle Sam knows best, patronizingly. That is all wrong. I think that is one of the things that I like about being with VITA. Not only is it an extension of my UNCSTD work, but also it is with an organization that does not try to bring solutions to the developing world; it waits for problems to come from the developing world to us, and then we say, "Here is our choice of solutions; what do you want?"

If UNCSTD went slowly and U.S. policy went slowly on it, it was because we were practicing the opposite of Uncle Sam knows best at that conference. We were practicing humility in a sense that we were waiting for the developing countries to define their needs, and the conference almost bogged down for failure to get this expression of desires, developing country desires, to know how to respond to it.

Mr. WINN. What is the dividing line between doing what you said and some of the things that you ran into in the UNCSTD conference where, in many cases, in the long run, it seemed to be a matter of trying to placate the Third World countries, or some of the Third World countries, probably the most outspoken?

Ambassador WILKOWSKI. Well, of course, it takes artful diplomacy. It takes a lot of experience. Dealing with the developing countries, I think, is an entirely different process than dealing with other countries. I have dealt with both. My diplomatic career was split between Western Europe and developing countries.

I do not have a perfect answer for this. I wish I did. It depends a lot on individuals, but I think the important thing is to learn how to listen with them, and I hope that when you hear testimony from the Government witnesses, they will tell you they have a good sense of what it is that the developing countries are trying to get out of this Conference.

Mr. WINN. I hope so, too, because in several other conferences that I am aware of, one of the first things we ran into was the fact that we got word behind the scenes that certain Third World countries had already met, either prior to coming to the conferences or they met when they arrived at the conferences, and the whole gist of the idea was to try to gang up on the United States.

Ambassador WILKOWSKI. We had a little bit of that at UNCSTD, too, you know.

Mr. WINN. Yes, you did.

Ambassador WILKOWSKI. We were terribly defensive. It was sort of gang up and kill the multinational corporations, and yet when we had a postmortem out at the AAAS in San Francisco, was it, Congressman Brown, where you met in the lobby? [Laughter.]

Mr. WINN. Was that because the crowd was so small or what? [Laughter.]

Ambassador WILKOWSKI. Well, it is amazing to find a friend in one of those AAAS annual meetings, I will tell you that. [Laughter.]

But what came out of it was a Mexican saying to me, "You know, it is a pity, really, you didn't get us talking with the people from corporations on your delegation sooner; we could have solved a lot of problems; but it was a good idea you had them in on your preparations and in on your delegation."

Mr. BROWN. Will the gentleman yield for a moment?

Mr. WINN. I will be glad to yield to the gentleman from California.

Mr. BROWN. I am not going to refer to the meeting in the lobby, but on this general topic of our relationship which sometimes appears to be adversarial or paranoid with regard to the Third World. I think all of us as practicing politicians recognize the need to play to the hometown audience. In most cases, these Third World nations are doing that.

You get acquainted with the leadership outside of the formal setting, and you find an awful lot of understanding that does not appear in the formal setting, where the role is to be the bad guy, to criticize the United States, to attack.

I was struck by this on a number of occasions both at Vienna and other conferences, and then it was brought home even more to me when, a few months after Vienna, I was visited by a delegation of the leaders of some of these same Third World countries, and they were active leaders with international positions, and they were asking—they were humbly asking—for more effective bilateral cooperation to solve some of the problems that those countries had which could be solved by help from the United States.

That is completely opposite from their posture at the Conference, which is one that we demand that you give to the whole of the Third World. They know that the whole Third World is not ready to even receive much, but we have to get beyond that posture, and we have to have the kind of sophisticated understanding that is required to do that, and a willingness to do that.

Thank you.

Mr. WINN. I think the gentleman makes a very, very good point there. Thank you very much.

Thank you, Mr. Chairman.

Mr. FLIPPO. Mr. Hollenbeck.

Mr. HOLLENBECK. Mr. Chairman, I do not have any questions of this witness, but I would like to echo the concerns as stated by the ranking minority member on the full committee and the observations of the gentleman from California, with whom I attended the UNCST Conference back in 1979.

Mr. FLIPPO. Very good. Mr. McGrath.

Mr. MCGRATH. I just have one question of Ambassador Wilkowski. Is there any real role for the congressional advisers?

Ambassador WILKOWSKI. Oh, I think there certainly is, both in the preparatory process and at the final session, and even at preparatory sessions. Certainly in preparation you people, your specialty here on this committee is science and technology, space science and technology. You know all the major actors. You should have, and you do have, a very clear appreciation of what some of our objectives and strategies should be. I think you are in an excellent position as counselor and adviser, and I think your opinions should be taken account of, and I think this is an excellent opportunity for this exchange of views.

We had the good fortune of having Congressman Brown and others come up our preparatory sessions. They had lunch with some of our own intractable, difficult delegations. They were very helpful in bridging differences.

Then again at Vienna we had a very large delegation of Congressmen for 2 or 3 days, and here again, we were able to have them bring back realities of domestic politics to some of these delegates who were being very, very unreasonable. So it can be helpful, yes, indeed.

Mr. McGRATH. Thank you.

Mr. FLIPPO. Mr. Lowery.

Mr. LOWERY. Thank you, Mr. Chairman.

Ambassador, what weight do these conferences hold in the overall picture of international relations?

Ambassador WILKOWSKI. What weight? Weight as measured within the bureacracy, whether international organizations——

Mr. LOWERY. In terms of international relations.

Ambassador WILKOWSKI. Are an important part of the State Department apparatus and whether they count on that a lot?

Mr. LOWERY. Yes.

Ambassador WILKOWSKI. I think that multilateral diplomacy, as I indicated, is going to be increasingly important to our diplomacy of the eighties because so many of the problems simply cannot be solved bilaterally, and I think we should increasingly give more attention to multilateral diplomacy, and that is why I am delighted that the State Department finally has a handbook, and how-to-do-it kind of book for practitioners, and it is also trying to develop a corps of multilateral diplomatists, and universities like Georgetown are trying also to draw lessons. We now have two cases studies on conference diplomacy and others.

I think, increasingly, we should give more attention to it. Now that I am outside of the Government, I can say quite easily, we do not give enough. I do not think we do give enough to it. In my prepared statement, I say that we cannot have on-and-off diplomacy at the United Nations. You know, we cannot take problems there when it suits our interests and then not go or not participate actively when there are problems that interest other countries more than us. It has to be consistent.

Mr. LOWERY. Are there results that can be cited from previous conferences on science and technology-related issues?

Ambassador WILKOWSKI. I didn't understand the question, sir.

Mr. LOWERY. Are there specific results you can cite from some of the previous conferences, bilateral as well as multilateral conferences, on the influences of science and technology issues?

Ambassador WILKOWSKI. Yes; let's just take UNCSTD, which I know best of all, although I attended the Energy Conference at Nairobi and the Deserts Conference before it.

In the case of the United Nations, I think the benefits to the U.N. from the UNCSTD Conference, confusing and frustrating as the whole process, is a better sense of who does what at the United Nations in science and technology. That was never looked at in any coherent or whole manner, and there is now an office there that I think is able to deal with it, and deal more effectively, because authority has been placed at a higher level. The funding of it is still not very good at the United Nations.

For the U.S. Government itself, I think it did very much the same thing. We made a lot of discoveries in our UNCSTD operations. We found out that sort of the right hand of the Government didn't know what the left hand was doing in science and technology. We were able to define that better, and now I think we have the National Academy of Sciences engaged in an excellent program in science and technology which might not have happened if it had not been for the Vienna Conference.

Mr. LOWERY. Is the Soviet Union as much of a target for some of the saber-rattling, if you will, from Third World nations as are we?

Ambassador WILKOWSKI. I would say we are a greater target. We get more darts.

Mr. LOWERY. But why is that?

Ambassador WILKOWSKI. I think we are probably an easier target. You know, if you risk a lot, you get out in front, you get exposed more, and so you get more darts thrown at you, and the Soviet Union has been attacking colonialism, which appears in some instances to developing countries.

I do not know why it is, frankly, that we do get so much more, but we do.

Mr. LOWERY. They attack colonialism with their own experience in Eastern Europe? It is a great irony.

Thank you.

Mr. FLIPPO. Thank you.

Would it be possible for us to get the UNCSTD case study for our records?

Ambassador WILKOWSKI. Yes, Mr. Chairman. I will speak with Georgetown University. It is at the publishers now. It is going to sell for $3.50 a copy. [Laughter.]

But I will try to have them make an exception so that each one of your gets a gratis copy for your contributions to us in the past.

Mr. FLIPPO. Since we are trying to save as much money as possible, that would be appreciated. [Laughter.]

Thank you so much for your testimony. It will be very helpful to us.

Ambassador WILKOWSKI. You are welcome. It is a pleasure. Thank you very much.

Mr. FLIPPO. Thank you very much.

Ambassador WILKOWSKI. Thank you.

Mr. FLIPPO. Our final two witnesses are the following: the Honorable James M. Beggs, the Administrator of NASA, and when he goes to Vienna, he will be Ambassador Beggs. We are delighted to have you, and we have Ambassador Gerald Helman with him, also.

We appreciate you gentlemen's patience today. I know you are very busy and have many demands on your time, but I believe this is most beneficial for us.

Thank you so much.

## STATEMENT OF HON. JAMES M. BEGGS, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, AND U.S. REPRESENTATIVE TO UNISPACE '82, ACCOMPANIED BY HON. GERALD HELMAN, U.S. AMBASSADOR AND COORDINATOR FOR UNISPACE '82

Mr. BEGGS. Thank you, Mr. Chairman.

It is a pleasure to appear today to testify as the representative of the United States to the second U.N. Conference on the Exploration and Peaceful Uses of Outer Space, or Unispace '82.

I am pleased to report that the preparations are going well, and our presence at Unispace in Vienna in August promises to be strong and effective. The Administration views Unispace as an excellent opportunity for the United States to reaffirm its commitment to international cooperation in the peaceful uses of outer space and to emphasize our role as the world leader in space.

I would like to describe the organization and status of the U.S. preparations for Unispace, touching particularly on the role of NASA and the State Department Coordinator's Office in this process. Regarding the Department of State's role, I would like to introduce Ambassador Gerald Helman, the Department's Coordinator for Unispace, who is well known to most of you. Since our activities have been so interconnected, we have chosen not to give separate testimony but to make ourselves available for questions following this testimony.

Also, I would like to discuss the role of the U.S. delegation in the preparatory process. In addition, I will identify and review the major political issues which we expect to arise during the course of the Conference. Lastly, I will discuss current U.S. efforts to assist developing countries in benefiting from the application of space technology that we will be highlighting at Unispace.

The U.S. delegation, the composition of which will be announced soon, will be taking an increasingly active role as the Conference approaches. It includes senior decisionmakers from the executive branch, industry, academia, and the Congress, who represent a broad spectrum of the U.S. society and will fully represent and further U.S. interests. I am confident that we have the proper representatives to insure that we address both the practical as well as any political issues which will be encountered at Unispace.

Mr. Chairman, the U.S. delegation will be approaching this conference with the conviction that there are a number of important objectives to be achieved. Very specifically, we have an important story to tell about our many achievements in space, the openness of our programs to international cooperation, and U.S. leadership in developing space technology of practical benefit to all people. The composition of our delegation, what we say at the Conference, and the quality of our exhibit, will show that the U.S. space program is an expression of that which is most creative and most optimistic in American society.

There are important issues to be discussed, and most of these are covered in the agenda of the Conference. Both in the formal conference sessions and in the private discussions, the U.S. delegation will be reviewing, with responsible officials from all over the world, how best to improve international cooperation in outer space.

Other governments will be attending Unispace with their ideas and their concerns. We hope that Unispace will provide a meeting ground where these ideas and concerns can be translated into an ordering of priorities for the future.

Finally, we hope that Unispace evokes from people around the world the continuing excitement of outer space exploration and use and informs them of the new benefits which outer space technology holds for the betterment of life on Earth.

Before reviewing the major issues which the U.S. delegation will be prepared to deal with at Unispace, I would like to touch on some of the major areas of our preparatory activities, in particular the U.S. national exhibit and demonstrations.

The United States will participate at the international exhibit of space technology which will be held during Unispace. The theme of the U.S. national exhibition is "Working Together to Benefit Spaceship Earth." The United States will also participate in the program of live demonstrations of space technology which the U.N. is sponsoring for Conference participants.

The U.S. Interagency Working Group for Unispace is preparing a series of issue and background papers for use by the U.S. delegation. The background papers cover various aspects of the U.S. space program and were written to correspond with the major items on the Unispace agenda. The issue papers cover the political issues which we expect will arise at the conference. In addition to providing the delegation with these papers, I have begun to organize a series of briefings to provide more detailed information on the issues and to coordinate our strategy for the Conference. It is my view that the preparations we are making will fully equip the U.S. delegation to deal effectively with the issues which might arise during the conference. There obviously will be points of controversy at the conference, and I would like to discuss some of these. I would like to also express my conviction that they can be dealt with effectively.

Although it is not on the agenda, a number of countries have expressed concern that outer space may be militarized and that this not only will increase international instability but will diminish the possibility of sharing in peaceful space applications. The concern appears to go beyond the issue of arms control to the use of outer space by the military. In addressing this question, we will make clear that we do not want to see an arms race in outer space and that the United States is prepared to deal with the variety of technical questions through the Committee on Disarmament to which the General Assembly has assigned the subject of arms control in space. We will also stress the valuable role military activities play in maintaining peace by providing advanced methods of verifying compliance with strategic arms control agreements. We will work to insure that any debate on this issue at Unispace will not diminish the prospects for dealing with the subject constructively in the Committee on Disarmament.

The second issue concerns future use of the geostationary orbit and the radio frequency spectrum for communications satellites. Some developing countries are concerned that the geostationary orbit will not be available to them in the future because of the rate at which more developed countries are deploying satellites. This has led many of these developing countries to insist that their interests be specially provided for through, for example, the regulation and use of the radio spectrum and the allocation of slots through a priori planning. It has even led a few of these countries to assert claims of sovereignty over the geostationary orbit. We obviously reject any claims of sovereignty over the geostationary orbit. The Outer Space Treaty has established that there can be no claims of sovereignty to outer space.

It is our view that debate on these issues should in no way prejudge the work of the ITU. We support access by all countries to the geostationary orbit and radiofrequency spectrum and encourage attention by the international community to future needs of developing countries in the use of these resources. The United States, however, rejects the idea of a priori allocation, as we believe it to be counterproductive.

In the original draft of the conference report, there were several proposals that space activities such as meteorology, navigation, and land remote sensing should be internationalized, or that the United Nations should be given an enhanced coordinating role relating to them. Although many of these proposals have been moderated, we expect that proposals for studies of international systems, particularly in the area of remote sensing, will be reiterated at Unispace. From the U.S. point of view, existing international cooperation should first be recognized and examined and other modalities analyzed carefully against national objectives and requirements, before moving to consideration of additional international institutions.

Over the long term, it might make sense to develop a broader international framework for these programs. However, we have not yet seen merit in the suggestion that the establishment of new U.N. mechanisms is the way to accomplish this objective.. Efforts should first focus on making the current work of the U.N. in this area more efficient.

Some countries may also express their desire for guarantees regarding the continuity of remotely sensed data reflecting concerns in the developing world that continuity of data from space systems may be interrupted. We fully recognize the desirability, from the users' standpoint, of assurances for continuity of services and reliable dissemination of data at reasonable cost. However, it is not within the mandate of Unispace to require guarantees from national operators of not-yet-operational remote sensing systems. The question is a relevant one, and its discussion may assist system operators in addressing it more effectively.

The issue of technology transfer inevitably comes up at all U.N. conferences, and Unispace will probably be no exception. It became clear during the United Nation's review of the conference report that some countries will attempt to apply the standard U.N. prescriptions for technology transfer to the area of space exploration. There are technology gaps between developed and developing countries, but there are no quick and easy solutions to this problem. The delegation believes that sensitivity to the issue, improved international cooperation, commercial arrangements with the U.S. private sector, and self-help by developing countries are of greatest relevance here.

There are already significant U.S. efforts underway in response to the desire of developing countries to increase their involvement in space activities, a desire that will find an important focal point in Unispace '82. The United States will emphasize these efforts. On the commercial level, it should be recognized that many U.S. companies are providing technical services which no other countries can currently provide in the area of application of space technology worldwide. On the Government level, the Agency for International Development is providing assistance in applying remote sensing and satellite communications in many areas crucial to social and economic development.

The United States will attempt, through Unispace, to further the utilization of space technology for the benefit of all mankind. The Interagency Group is working intensively to complete development of a package of U.S. initiatives for Unispace as one of its highest priority areas of activity.

One initiative the United States plans to undertake in the area of remote sensing is preparation of a catalog to be distributed at Unispace which will break down, by region and country, the worldwide Landsat data available in the United States, collected since 1972 by Landsats 1, 2, and 3. These data are currently archived at the EROS Data Center in Sioux Falls, S. Dak. Such a catalog has not been prepared since 1974. These catalogs should be of immense practical benefit to the international user community. The United States also hopes to announce the preparation of a consolidated catalog series including all Landsat holdings, non-United States as well as domestic. These catalogs will serve as a comprehensive record of all data acquired during the first 10 years of Landsat operations and would be developed through the cooperative effort of the 10 countries operating their own Landsat ground stations.

The initiatives we plan to take, the U.S. national exhibit and demonstrations at Unispace '82, and the presence of a strong U.S. delegation will serve to exemplify U.S. leadership in the peaceful uses of outer space. Equally important, the delegation will work to generate greater awareness among the developing countries of the benefits of space technology and the opportunities available to them so that they may increase their involvement in this area.

In summary, substantial progress is being made in all areas of U.S. preparations. I believe that the United States has an impressive story to tell and I am confident that we have a delegation to tell it.

Thank you, Mr. Chairman. That concludes my prepared remarks.

[The prepared statement of Mr. Beggs follows:]

## PREPARED STATEMENT OF JAMES M. BEGGS

Mr. Chairman and members of the subcommittee, it is a pleasure to appear today to testify as The Representative of the United States to the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space or Unispace 1982.

It is timely to hold this hearing as conference preparations are now well underway and interest in Unispace 1982 has been growing in recent months. I am happy to report that preparations are going well and our presence at Unispace in Vienna in August promises to be strong and effective. The Administration views Unispace as an excellent opportunity for the United States to reaffirm its commitment to international cooperation in the peaceful uses of outer space and to emphasize our role as the world leader in space.

I would like to describe the organization and status of U.S. preparations for Unispace, touching particularly on the role of NASA and the State Department Coordinator's Office in this process. Regarding the Department of States' role, I would like to introduce Ambassador Gerald Helman, the Department's Coordinator for Unispace, who is well known to most of you. We have been working very closely together on Unispace preparations. Since our activities have been so interconnected, we have chosen not to give separate testimony, but to make ourselves available for questions following this testimony.

Also, I would like to discuss the role of the recently-named U.S. Delegation in the preparatory process. In addition, I will identify and review the major political issues which we expect to arise during the course of the conference. Lastly, I will discuss current U.S. efforts to assist developing countries in benefiting from the application of space technology that we will be highlighting at Unispace.

Before beginning a review of the U.S. preparatory process, I would like to provide some background information about Unispace 1982, touching on its origin, purpose and agenda.

Unispace 1982 is the second U.N. conference of its kind. The first was held in Vienna in August 1968. Both conferences originated with the U.N. Committee on the Peaceful Uses of Outer Space.

It is interesting to note that former U.N. Secretary General Kurt Waldheim was, at that time, Chairman of the Outer Space Committee and served as President of the 1968 Outer Space Conference. The U.S. Delegation to that conference, upon which the present delegation to Unispace is modeled, included a number of distinguished members and was headed by NASA Administrator James Webb. The purpose of the 1968 conference was much the same as that of Unispace 1982: to examine the practical benefits of space science and technology and to explore ways in which more countries could become involved in the peaceful uses of outer space.

In the 14 years which followed the 1968 Conference, the world has seen great progress in the peaceful uses of outer space. More and more countries are enjoying the benefits of the practical application of space technology. Examples of developing countries' application of space technology include: Indonesia connecting its thousands of islands together through a national communications satellite system; India building its own satellites and launch vehicles and establishing a multipurpose, operational, communications and meteorological satellite system; and five developing countries—Argentina, Brazil, India, Indonesia and Thailand—establishing their own Landsat data acquisition and processing facilities. The dramatic expansion of international involvement in space activities can be illustrated by the growth in membership of international organizations benefitting from these activities. The membership of the U.N. Outer Space Committee has grown from twenty-eight in 1968 to fifty-four today. Intelsat had 68 members at that time and has now grown to 105. Over 140 countries are now using the Intelsat system. The International Maritime Satellite Organization (Inmarsat) began operation in February 1982, and already has over 30 members. In 1968, the European Space Agency did not exist in its present form. Seventy-eight countries took part in the first U.N. Outer Space Conference; approximately 140 countries and international organizations are expected to take part in Unispace '82.

In 1978, the members of the Outer Space Committee decided that the dramatic advances in space activities since the 1968 conference created the need for another worldwide space conference. The Outer Space Committee was designated by the U.N. General Assembly to coordinate all preparatory activities.

The United States, which has been a leading member of the Outer Space Committee since it was first created by the U.N. as an ad hoc committee in 1958, participated actively in the initial stages of planning for Unispace 1982. As a result of our efforts the Committee agreed upon a balanced conference agenda and on a conference venue other than Moscow.

The primary purpose of Unispace is to promote greater international awareness of the practical benefits of the application of space science and technology. The conference will also explore ways in which many countries, particularly those in the developing world, can increase their involvement in outer space activities and consequently may learn how to apply space technology to help solve problems on Earth.

The agenda for Unispace is focused on three main areas: (1) the state of space science and technology; (2) application of space science and technology; and, (3) international cooperation and the role of the United Nations. To coordinate all preparations, a Secretariat for Unispace was established by the U.N. in December 1980 with Indian Physicist Professor Yash Pal serving as Secretary General. The Secretariat, about which Unispace Deputy Secretary General Dr. Jerry Grey will brief you in more detail, is responsible for all aspects of conference preparations. The Secretariat has published an impressive amount of valuable documentation including technical Background Papers, National Papers and a Conference Report.

I will now review the organization and status of U.S. Government preparations for Unispace.

As you know, the United States chose not to participate in preparations for Unispace for much of 1981 because of an impasse concerning selection of key United Nations personnel involved in outer space affairs. Although the decision to take this position hampered U.S. preparations, upon its satisfactory resolution in late December 1981, work began quickly and intensively to ensure the best possible representation of U.S. interests at Unispace. I have been most gratified with the efforts of the State Department and other interested government agencies in accomplishing a tremendous amount of work in a short amount of time. I also want to acknowledge the efforts of the AIAA and the U.S. private sector which have become involved in the preparations in a major way and are helping to ensure that the United States will be an effective and well-prepared participant in this important conference.

Through the combined leadership of NASA and the State Department Coordinator's Office, an interagency working group has been meeting regularly since January 1982. Members of this group include OSTP, Commerce, AID, DOD, the International Communications Agency, USGS, USDA, and the FCC. Congressional staff members have also attended some of these meetings. Sub-working groups have been set up to work on the U.S. exhibition, demonstrations, initiatives and public affairs strategy.

One of the first activities of the interagency group was to produce a U.S. National Paper for Unispace. The U.S. National Paper is not a comprehensive review of all U.S. space activities but instead covers those aspects of the U.S. space activities of particular relevance to developing countries. This includes applications of remote sensing and communications and increased opportunities for greater participation in space activities offered by the U.S. Space Transportation System. The paper also touches on the U.S. space science activities and the value of the many "spinoffs" from the U.S. space program.

The U.S. Delegation, the composition of which has been announced recently, will be taking an increasingly active role as the conference approaches. It includes senior decision-makers from the executive branch, industry, academia and the Congress, who represent a broad spectrum of U.S. society and will fully represent and further U.S. interests. I am confident that we have the proper representatives to ensure that we address both the practical as well as any political issues which will be encountered at Unispace. With your permission, I will provide the Subcommittee with a list of Delegates for inclusion in the record.

In addition to the formation of the U.S. Delegation, Ambassador Helman and I have met with interested Members of Congress, their staffs and representatives of non-governmental organizations in the United States to discuss the status of our preparations.

Mr. Chairman, the U.S. delegation will be approaching this conference with the conviction that there are a number of important objectives to be achieved. Specifically:

We have an important story to tell about our many achievements in space, the openness of our programs to international cooperation, and U.S. leadership in developing space technology of practical benefit to all people. The composition of our delegation, what we say at the concerence, and the quality of our exhibit, will show that the U.S. space program is an expression of that which is most creative and most optimistic in American society.

There are important issues to be discussed and most of these are covered in the agenda of the conference. Both in the formal conference sessions and in the private discussions, the U.S. delegation will be reviewing, with responsible officials from all over the world, how best to improve international cooperation in outer space. Other governments will be attending Unispace with their ideas and their concerns. We hope that Unispace will provide a meeting ground where these ideas and concerns can be translated into an ordering of priorities for the future. In short, we hope that Unispace '82, as Unispace 1968, can help in establishing a future agenda for international cooperation.

Finally, we hope that Unispace evokes from people around the world the continued excitement of outer space exploration and use, and informs them of the new benefits which outer space technology holds for the betterment of life on earth.

Before reviewing the major issues which the U.S. Delegation will be prepared to deal with at Unispace, I would like to touch on some of the major areas of our preparatory activities, in particular the U.S. national exhibit and demonstrations.

The United States will participate in the international exhibition of space technology which will be held during Unispace. The theme of the U.S. national exhibition is "Working Together to Benefit Spaceship Earth". Our exhibit, which combines in one area a U.S. Government exhibit and the exhibits of 12 U.S. companies, promises to be one of if not the best at the Conference. It will be a truly national effort with the government and private sector closely integrated. In general, we view the exhibition as an excellent opportunity to tell our story and make clear that the U.S. private sector has played a unique and vital role in making the United States a world leader in space. I have brought along a blueprint of the U.S. exhibit and copies of a poster specially produced for the exhibit for the Subcommittee's information.

In addition to our exhibit, the United States will participate in the program of live demonstrations of space technology which the U.N. is sponsoring for conference participants. The Communications Satellite Corporation (Comsat) is providing a satellite telecommunications link between Vienna and the U.N. Headquarters in New York City to provide remote interpretation services for part of the conference proceedings. NOAA is contributing hardware for use in a demonstration of meteorological satellites coordinated by the World Meteorological Organization. NASA is sponsoring a demonstration of advanced equipment for processing of remote sensing data. NASA will also conduct a demonstration of the "spinoff" technology of photovoltaics which is being utilized to provide electricity in developing countries. The Agency for International Development (AID) will conduct a demonstration of communication equipment for use in remote areas of developing countries as part of their Rural Satellite Program. Many of these demonstrations involve contributions from the private sector, which will illustrate to conference participants the fact that U.S. accomplishments in space are of practical benefit to all people and that it is the result of public and private sector teamwork.

In March of this year, a U.S. Delegation, headed by Ambassador Helman, participated in a detailed review of the draft Conference Report for Unispace by the U.N. Outer Space Committee. It covers many aspects of the current and planned activities in outer space by many countries. It also covers many concerns about various aspects of these activities and it makes recommendations for action by the international community. The Outer Space Committee has reached consensus on all but 15 of the Report's 430 paragraphs. The United States, working closely with other concerned delegations, succeeded in balancing much of the Report's language so that it more accurately reflects the views of all countries on the current status and future direction of space activities. Although we would have preferred consensus on the entire Report, we were very pleased that the Committee was able to agree on the large number of diverse and, in some cases, controversial issues in the Report. In a moment, I will outline the major issues which are the source of disagreement in many of the 15 paragraphs.

Based on the positions developed by the United States in the U.N. Outer Space Committee's review of the Conference Report, the U.S. interagency working group for Unispace is preparing a series of issue and background papers for use by the U.S. Delegation to Unispace. The background papers cover various aspects of the U.S. space program and were written to correspond with the major items on the Unispace agenda. The issue papers cover the political issues which we expect will arise at the conference. In addition to providing the Delegation with these papers, I have begun to organize a series of briefings to provide more detailed information on the issues and to coordinate our strategy for the conference. It is my view that the preparations we are making will fully equip the U.S. Delegation to deal effectively with the issues that might arise during the Unispace Conference.

There obviously will be points of controversy at the conference, and I would like to discuss some of these. I would like to also express my conviction that they can be dealt with effectively.

Although it is not on Unispace's agenda, a number of countries have expressed concern that outer space may be "militarized" and that this not only will increase international instability, but will diminish the possibility of sharing in peaceful space applications. The concern appears to go beyond the issue of arms control to the use of outer space by the military. In addressing this question, we will make clear that we do not want to see an arms race in outer space and that the United States is prepared to deal with the variety of technical questions through the Committee on Disarmament to which the General Assembly has assigned the subject of arms control in space. We will also stress the valuable role military activities play in maintaining peace by providing advanced methods of verifying compliance with strategic arms control agreements. We will work to ensure that any debate on this issue at Unispace will not diminish the prospects for dealing with the subject constructively in the Committee on Disarmament.

The second issue concerns future use of the geostationary orbit and the radio frequency spectrum for communications satellites. Some developing countries are concerned that the geostationary orbit will not be available to them in the future because of the rate at which more developed countries are deploying satellites. This has led many of these developing countries to insist that their interests be specially provided for through, for example, the regulation and use of the radio spectrum and the allocation of slots through a priori planning. It has even led to few of these countries to assert claims of sovereignty over the geostationary orbit. We obviously reject any claim of sovereignty over the geostationary orbit. The Outer Space Treaty has established that there can be no claims of sovereignty to outer space.

Issues relating to future use and regulation of the geostationary orbit and spectrum resources are particularly strongly-felt for some developing countries and we are concerned that Unispace not be used to prejudge the consideration of these issues before the forthcoming conferences of the International Union (ITU), in particular the ITU Plenipotentiary to be held this fall the 1983 ITU Administrative Radio Conference on DBS in Region 2, and the ITU Space World Administrative Radio Conference to be held in 1985 and 1987.

The delegation's position on this issue, which is being fully coordinated with the government agencies involved in preparations for ITU meetings, is that consideration of technical issues relating to regulation of international telecommunications are the responsibility of the ITU. It is our view that debate on these issues at Unispace should in no way prejudge the work of the ITU. The delegation supports access by all countries to the geostationary orbit and radio frequency spectrum, and encourages attention by the international community to the future needs of developing countries in the use of these resources. The delegation rejects the idea of a priori regulation as it is believed to be counterproductive.

The United States supports rational management of these resources as opposed to inflexible planning, as this holds the best promise of allowing the technological advances needed to increase capacity and provide more cost effective systems.

In the original draft of the Conference Report, there were several proposals that space activities such as meteorology, navigation and land remote sensing should be internationalized or that the U.N. should be given an enhanced coordinating role relating to them. Although many of these proposals have been moderated, the delegation expects that proposals for studies of international systems, particularly in the area of remote sensing, will be reiterated at Unispace. From the U.S. point of view, existing international cooperation should first be recognized and examined and other modalities analyzed carefully against national objectives and requirements, before moving to consideration of additional international institutions.

There are already many examples of international cooperation in the peaceful uses of space. I have already mentioned ESA, Intelsat and Inmarsat. The accomplishments through Landsat on the international level are well known to this Subcommittee. Other examples include the World Meteorological Organization (WMO), which is doing an outstanding job in coordinating international activities in the area of space meteorology. In land remote sensing, current and prospective system operators are consulting with each other and with users of data in the developing world to ensure compatibility and complementarity of their efforts. Over the long term, it might make sense to develop a broader international framework for these programs. However, we have yet to see merit in the suggestion that the establishment of the U.N. mechanisms is the way to accomplish this objective. Efforts should first focus on making the current work of the U.N. in this area more efficient.

Some countries may also express their desire for guarantees regarding the continuity of remotely sensed data reflecting concerns in the developing world that continuity of data from space systems may be interrupted. We fully recognize the desirability, from the users standpoint, of assurances for continuity of services and reliable dissemination of data at a reasonable cost. However, it is not within the mandate of Unispace to require guarantees from national operators of not-yet-operational remote sensing systems. But the question is a relevant one and its discussion may assist system operators in addressing it more effectively.

The issue of technology transfer inevitably comes up at all U.N. conferences, and Unispace will probably be no exception. It became clear during the U.N.'s review of the Conference Report that some countries will attempt to apply the standard U.N. prescriptions for technology transfer to the area of space exploration. There are technology gaps between developed and developing countries, but there are no quick and easy solutions to this problem. The delegation believes that sensitivity to the issue, improved international cooperation, commercial arrangements with the U.S.

private sector and self-help by developing countries are of greatest relevance here. The United States will continue to invite international cooperation in its space programs and to make the knowledge gained from them available for the benefit of all people. It is very possible that many developing countries are not aware of how much technical information is available through, for example, the National Technical Information Service (NTIS) of the Department of Commerce. We feel that one of the important contributions we can make at Unispace is to make countries aware of the information available and how they can obtain this information.

Now that I have outlined some of the major Unispace issues, I will begin the final portion of my testimony in which I will review some initiatives we are considering for the conference, and the related, current U.S. activities to assist developing countries.

There are already significant U.S. efforts underway in response to the desire of developing countries to increase their involvement in space activities, a desire which will find an important focal point in Unispace '82. The United States will emphasize these efforts at Unispace. In the commercial level it should be recognized that many U.S. companies are providing technical services, which no other countries can currently provide, in the area of applications of space technology worldwide. On the government level, the Agency for International Development is providing assistance in applying remote sensing in many areas crucial to social and economic development and this has resulted in a series of successful projects in several developing countries and the establishment of regional and national remote and sensing centers in Africa and Asia. More specialized assistance and training in remote sensing applications is provided by the U.S. Geological Survey and the Department of Agriculture. The AID Rural Satellite Program, which will use pilot projects to demonstrate the use of communication satellites to provide telecommunications to remote areas in developing countries, is also underway with initial pilot projects to take place in Indonesia, Peru and Senegal. The level of the on-going AID effort in space related projects is over $50 million. Lastly, various U.S. Government technical experts will continue, as agency resources permit, to participate in U.N. sponsored seminars, symposia and workshops which deal with application of remote sensing and space communications in social and economic development.

These activities as well as other U.S. space programs of interest to developing countries are more fully described in the U.S. National Paper.

The United States attempt, through Unispace, to further the utilization of space technology for the benefit of all mankind. The interagency group is working intensively to complete development of a package of U.S. initiatives for Unispace, as one of the highest priority areas of activity between now and Unispace.

One initiative the United States plans to undertake in the areas of remote sensing is preparation of a catalog to be distributed at Unispace which will break down, by region and country, the worldwide Landsat data available in the United States collected since 1972 by Landsats 1, 2 and 3. These data are currently archived at the EROS Data Center in Sioux Falls. South Dakota. Such a catalog has not been prepared since 1974. These catalogs should be of immense practical benefit to the international user community. The United States also hopes to announce, at Unispace, the preparation of a consolidated catalog series including all Landsat holdings, non United States as well as domestic. These catalogs will serve as a comprehensive record of all data acquired during the first 10 years of Landsat operations and would be developed through the cooperative effort of the 10 countries operating their own Landsat ground stations.

The initiatives we plan to take, the U.S. National Exhibit and demonstrations at Unispace 1982 and the presence of a strong U.S. Delegation will serve to exemplify U.S. leadership in the peaceful uses of outer space. Equally important, the Delegation will work to generate greater awareness, among the developing countries, of the benefits of space technology, and the opportunities available to them so that they may increase their involvement in this area.

In summary, substantial progress is being make in all areas of U.S. preparations for Unispace '82. I believe the United States has an impressive story to tell and I am confident that we have the delegation to tell it.

Thank you Mr. Chairman. Ambassador Helman and I would be happy to answer any questions you or your colleagues may have.

Mr. FLIPPO. Thank you, Mr. Beggs. I appreciate that testimony.

Mr. Beggs, the subcommittee has been made aware of a possible U.S. initiative which some have referred as HOPE. I wonder if you have anything about that you could tell us. Tell the committee about it.

Mr. BEGGS. Yes, sir. We have under consideration a proposal for a global research program involving international cooperation that we have titled "Global Habitability." It would encompass decadal study of physicial, biological chemical, human and other factors effecting changes in the habitability of our Earth in the air, sea, water, and all of the other various things that go to make up our environment.

As you will recognize, parts of such a study have been underway for a long time in the various programs that we have initiated in this country as well as in our international cooperative endeavors, particularly with ESA, to make a beginning in understanding the effect of population and the effect of changes that are affecting life on our planet.

We think that it would be a very, very significant step forward if we could get worldwide cooperation, in announcing this concept at Unispace and inviting all countries as well as international organizations to assist us in our endeavors to study this problem.

Mr. FLIPPO. Will any legislation be required for the new initiative that is currently underway?

Mr. BEGGS. I don't believe so, although we will, of course, expect to share plans for the program with the Congress as it develops, with the aim of getting your concurrence. There may be some budgetary impacts in the future, and there would be, of course, the necessity of looking at and reviewing whatever international agreements may have to be drawn up. I think, however, we have ample authority to move forward with the initiative and present it to the Conference in the hope that we would get a positive response from enough of the world so that we could put together a program that would be definitive.

Mr. FLIPPO. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

First, I want to congratulate you. You mentioned there in the last part of your testimony, Jim, about the Landsat catalog. I think that is very constructive, and I think it should be a very interesting highlight of the U.S. presentation and something that the other countries could take home with them. It should initiate a lot of questions and discussion on the Landsat subject.

I am a little concerned, and I may have misread you or misinterpreted what you were saying, but as I understood you to say that NASA was preparing background issues, background papers, and all of these types of things. Why are you doing that when the delegation has not been named yet and the other people that are going to be named in the delegation have not had a chance to have any input in that? You may be the lead agency, but there are other agencies that are involved. Did I misunderstand you?

Mr. BEGGS. Let me clarify this point. First of all, when I said "you," I include NASA and the Department of State, and the papers which have been jointly prepared by the two organizations because they are most familiar with the subjects covered in the papers. As you know, the conference report has already been drafted. As Dr. Grey mentioned in his testimony, there is general agreement on about 95 percent or maybe even 98 percent of the report.

There are 15 paragraphs still unagreed upon which will be issues with us. We are trying to precisely outline them to develop a U.S. position broadly through the executive department.

I think we almost have to because of the lateness of the hour in the preparations for the Conference. We would have to do that even if we had a number of months still remaining between now and the Conference to provide the delegation with the necessary background information needed to make up their own minds and to bring themselves up to speed on the pending issues.

Mr. WINN. Well, they are not policy positions.

Mr. BEGGS. Most of these issues are not new issues. They are of some standing.

Mr. WINN. Yes; I realize that.

Really, basically, your position papers are just what you say, position papers, but they are not necessarily policy papers, are they? Because you are asking a delegation, as I understand it—I know the congressional delegation has not been appointed yet, and I know a great many of the outsiders have not been appointed yet, and if you are going to have them participating as a member of your delegation and a working member of the delegation, they are going to have to have something to say about those position papers.

Mr. BEGGS. Yes, and indeed they will.

Mr. WINN. All right.

Mr. BEGGS. I would like to emphasize again that most of these issues are not new issues, and on many of them there already is an established U.S. policy. But for those that are not, of course, the delegation will have their say.

Mr. WINN. How soon do you think the rest of the delegation will be named? How soon do you think the announcement is going to be made of the names of the delegates?

Mr. BEGGS. Next week.

Mr. WINN. Good reply.

Mr. BEGGS. I would like to ask Ambassador Helman to comment on that.

Mr. WINN. We would like to hear from the Ambassador, and he is certainly an experienced hand on this type of Conference.

Mr. HELMAN. Thank you, sir.

On the position and background papers, what we want to do is put them in proper shape so when the delegation is appointed and gets together, they have material from which to work. We do not have enough time to begin the drafting of these papers after the first meeting of the delegation. We are going to have to prepare material beforehand, have it ready for the delegates, certainly listen to their comments, make corrections where necessary, and then we will be prepared to go ahead.

Mr. WINN. Is there a plan to have a meeting of the delegation before they depart for Europe?

Mr. HELMAN. Yes; there is, and we are hopeful that once the delegation is announced we can then organize a meeting here in Washington in advance of departure, conduct a series of briefings, go over the position papers, talk about strategy, talk about the housekeeping matters as well of any delegation at any conference, and then proceed from there.

Mr. WINN. How many members do you expect to be named to the delegation? What are they talking about in numbers? I know it may vary a little.

Mr. BEGGS. In the order of 34 or 35, Mr. Winn.

Mr. WINN. What is the main issue—you may have been in the room earlier, Jim. I didn't see you, but I asked several of the other witnesses, what is the main issue that you think that the United States ought to push or to project, not necessarily an image but an issue, at Unispace '82?

Mr. BEGGS. The thing what I would very much like to do in the Conference is to try to keep a positive approach to the Conference. We would like to come forward with the initiative I discussed and perhaps some other discussions on international cooperation. But, we do not want to get bogged down in the negative approach, which I think per force we will get into if we don't keep the emphasis on the positive.

Of course, there is the issue of the geostationary orbit and the radio frequency spectrum that is high on the agenda of a lot of countries of the Third World which will be represented at the Conference. It will be hard for us to take a positive approach to that, since we cannot accede to restrictions on what are currently agreed-to international approaches. But, I think that will be the most contentious issue which we will be confronted with. The other issue that will certainly be in discussion will be the question of the military use of space. We will, of course, take the position that I described in my statement; that is, that it is an issue for the Committee on Disarmament and not a proper subject for the Conference.

I believe those are the two issues that are most likely to give us the most difficulty. My hope is that we can keep the emphasis on the positive, which is looking to the future, toward greater international cooperation on what will indeed benefit mankind and the entire membership of that Conference and which this country has had a very positive and, I think, very productive program ongoing.

Mr. WINN. In your background issues and papers—either one of you can answer this—have you done anything about a discussion or thought about a discussion about peacekeeping satellites?

Mr. BEGGS. Yes. Mr. Helman may like to comment.

Mr. HELMAN. Well, there is a brief discussion of that, but I think on the idea that may be presented to Unispace, it is a French idea of an international verification agency. As you know, the United States has long opposed it ever since it was first presented by the French Government to the General Assembly of the United Nations back in 1978–79. I do not anticipate our position on that, as far as the French proposal is concerned, will change.

I have not had explained to me the details of your idea, sir, and as far as I am aware, it has not been staffed out.

Mr. WINN. No, it has not, because I have not done that much. It is not an original idea. I just think it is an idea whose time has come. I think the fact that the President is going to meet with Brezhnev and some other Russian leaders, I think it is the right time, if he is going to discuss the variations of problems between the two countries, I think one of the constructive things that they can discuss would be some type of a mutual, cooperative effort in space and through a peacekeeping satellite.

We have had cooperative efforts with the Russians before, and they were pretty successful. I think we ought to keep talking in that vein.

I might point out that I have already leaned over to the chairman and said that I am working on a resolution which would request that the U.S. delegation—and he is going to be one of them, I think, and I might be one—put forth for discussions on that issue.

So I might say that from a position paper or at least a background paper, we might want to work together on it.

Mr. **Helman**. Fine.

Mr. **Winn**. Thank you very much.

Thank you, Mr. Chairman.

Mr. **Flippo**. Mr. Brown.

Mr. **Brown**. Gentlemen, following up on Mr. Winn's inquiries, I followed the French proposal at a distance, and you indicated it did come up at the U.N. several years ago in connection with a special conference on disarmament. It was, in effect, swept under the rug by the device which we use here very often of having a study done. Unfortunately, it didn't stay swept because a study was made, and it is a subject of additional discussion now.

I am concerned that the U.S. posture on this—and I don't have any expectation of changing it—may be due just to the fact that it comes from the French, and we are mad at the French right now, or something like that.

There have been a number of suggestions made on the part of the Senate for similar types of international peacekeeping operations based upon our space capabilities, including a jointly manned satellite command post or some other real far out idea. They are made by responsible Senators—all Senators are responsible—and I think it would be a valuable initiative to suggest something of that sort as a part of the U.S. posture at this Conference.

Mr. Beggs, I cannot quite see why you take the position that an international conference which includes in its title the peaceful use of outer space cannot be concerned with the peaceful uses of outer space.

Mr. **Beggs**. I did not mean to imply that they cannot be concerned with it. I am not as familiar with the details of the inner workings and hidden mechanisms of the U.N. as Ambassador Helman, but my understanding is that they have various and sundry jurisdictions in the U.N., just as there are jurisdictions within the Congress of the United States, and that the particular issues of military belong in the Committee on Disarmament. But, with respect to the issue on remote sensing, it is entirely appropriate, and it has been raised. I guess the question is how far you take that with respect to discussions on peacekeeping satellites.

Mr. **Brown**. Well, I think the U.N., as a bureaucracy, is probably much like the Congress; it has a number of organizations where there are overlapping and joint and conflicting jurisdictions, and this may be one of them.

Frankly, I regret that we could not use this conference as a forum to discuss legitimate uses of space in connection with peacekeeping, but I understand that it is also a subject which could be taken up in the disarmament committee, and I just feel that we are missing an initiative.

Let me ask you a couple of other, less controversial questions. You have referred a couple of times to the problem of orbit allocations and the fear of the Third World nations that there will be a saturation of geostationary orbits. The claim to sovereignty, which I, of course, feel should be rejected, as you do, they will probably make another claim based upon some aspects of space as falling within the common heritage of mankind, that everybody ought to have a chance at it. I suppose we would reject that, likewise, on similar grounds, but our fundamental posture seems to me to be the one you express, that there is no real problem, that the development, the emergence of new technologies will not make limitations on orbital space a real problem. Is that your position?

Mr. BEGGS. Yes, sir, that is precisely our position. The technology is moving rapidly these days. Our view is that there is, within the technology, lots of room for solving the problems with which they are concerned.

Mr. BROWN. Is there any way in which we can get this across in specifically concrete ways that we can defuse the question?

Mr. BEGGS. We will have experts there to explain what is going on within the technology and the research that is underway. The basic problem is in gaining an understanding. Some of the technology is hard to understand, particularly for many of those who have not been exposed to it, and I suppose no matter how well you explain the fact that this problem is not a real problem, they will still feel that somewhere out there either the geography or the spectrum is going to get crowded and they are not going to be able to get in. But, we will try to do that.

Mr. BROWN. Well, there is a larger issue behind this. I don't like to see us continually going to international conferences and frustrating the legitimate or illegitimate aspirations of the third world because we don't have sense enough to allay their fears in some reasonable way. It is creating problems for us when we do that. I would like to see us diminish problems rather than create them.

Mr. BEGGS. I share that, sir.

Mr. BROWN. Would you see if that problem could not be addressed in some simple way, you know, by portraying a model of a communications satellite orbit a generation from now that will give some hope to these countries?

Mr. BEGGS. We will try, and I will take it on as a specific task.

Mr. BROWN. You mentioned, and I pleased that you are suggesting some initiatives in the way of cataloging Landsat data, and so forth. Have you given any thought to a structure referred to in some earlier conversations, possibly similar to Intelsat or Inmarsat, which would really give us, for the first time, some sort of a global system for Earth resources observation which the Third World nations could participate in, in the same way they do Intelsat and Inmarsat?

Mr. BEGGS. Yes, we have been thinking quite a lot about the possibility of putting together an international consortium for the remote sensing activity. The problem that we have in this arena is really the current state of the systems that are around. We have in being, with the Landsat, an experimental system, and that is what it is—an experimental system. We generate data slowly. It is not at a stage where it is truly available commercially, as was Comsat when Intelsat became an entity. At the same time, you have the French with their SPOT Image Company as well as the Japanese who are interested in this area. If we wait too long, we will probably lock into a competitive situation which will make international cooperation more difficult. If we move too quickly, we will probably set up something based on preliminary results which will not be optimum in terms of the system.

I think it is time to start discussions with other countries about how we could cooperate with them, how we could set standards, and how we might put together an international consortium, assuming that we are moving toward operational capability. But no one is operational as yet.

Mr. BROWN. Mr. Beggs, I consider that a disingenuous answer. [Laughter.]

I honestly do not feel that our satellite observation system should be labeled as experimental when we have been relying on it for 20 years.

Mr. BEGGS. I did not mean to imply that. But, I will repeat, the Landsat system is, in our eyes, still an experimental system, still a developmental system.

Mr. BROWN. That is because we choose to define it as experimental.

Mr. BEGGS. I will not quarrel with the terminology. But for whatever reasons, for the past several years, we have been pursuing technology at an ever-advancing level. We started with one level of technology. We will launch a new satellite on Friday with new technology and there is still another one planned. Our feeling was that we had not yet reached the point where we had the best combination of imaging and spectrum analysis to make an operational system, and it was in that context I was speaking.

I do believe that by the end of this year or early next year, we will turn this whole system over to NOAA. At that point, we will say it is as near to an operational system as we can make it at this point.

So I say again, it is not too early to start discussions on how we might cooperate with the other international entities who are interested in this and to consider the possibility of having a consortium of nations join together, because this is something that is, by its nature, international.

Mr. BROWN. Mr. Beggs, you and I both know there are a lot of other factors involved in this than mere state of technology. What I am afraid of, and what this committee is afraid of and what it has voiced many times, is that we are losing out in a position of global leadership because we have not done what you say we have to do in terms of defining and establishing that civilian system in such a way as to maintain our posture.

We are not only going to have competitors out there; we are going to be out of the market if we are not careful, and we don't want to see that happen. If the market is one that is best served by a global structure, then we ought to be taking the leadership in doing it. If it is not, we ought to be the world's best, and I don't think we are going to be.

This Conference is going to have some acrimonious discussion on it, I am quite sure.

Mr. BEGGS. Mr. Brown, I would not like the record to be left with the feeling that we are still not the world's best. I still think we lead in this technology.

Mr. BROWN. This experimental technology?

Mr. BEGGS. Yes, sir. What we are doing in Landsat-D is far in advance of what is even being planned by the other nations of the world which are interested in this area. We still are ahead. That is not to discount anything you have said with regard to the necessity to think in terms of international mechanisms to make this work better.

Mr. BROWN. Well, let me make just one additional point. I have taken too much time. Did American industry lose any commercial advantage as a result of Intelsat?

Mr. BEGGS. The answer to that, at the time, is clearly "no." We dominated this technology up until just a couple of years ago, when the competition started. Until just a few years ago, we sold all the satellites, the land stations, and the receiving stations.

Mr. BROWN. We created a market, in other words.

Mr. BEGGS. Yes, we created a market. Now competition is coming in, and we can expect this to be increasingly competitive in the future. But certainly American industry benefited by the creation of that entity for 20 years.

Mr. FLIPPO. Thank you. Mr. Nelson.

Mr. NELSON. Mr. Beggs, do we expect the Soviets to pull off any kind of PR stunt?

Mr. BEGGS. Yes. [Laughter.]

Mr. NELSON. What?

Mr. BEGGS. I don't fully know what they intend to do, Mr. Nelson. Of course, we are approaching the 25th anniversary of their first flight, and the Soviets, as we all know, like anniversaries. They will undoubtedly take advantage of the silver anniversary, if you will, of the initiation of the space age. They will be conducting a manned flight during the conference. They have reserved time for a broadcast from that station. I expect it will be from the station. We can anticipate that kind of thing which will be very impressive.

We will have with us Henry Hartsfield from the last flight, and Anna Fisher, who is one of the more articulate lady astronauts; and, we think we will have a good show to counter what they put on.

But what else they would do, I don't know. Do you have any idea, Jerry?

Mr. HELMAN. No.

Mr. BEGGS. They will be active, I am sure.

We will have a very representative exhibit. We have a good group from the industry which have joined with us, and we will have a U.S. exhibit. We will have a number of demonstrations. Comsat will have an active link between New York and Vienna where they will be transmitting some of the proceedings of the conference. We will use that link to make broadcasts from some of our research centers here in the United States to demonstrate some of the advanced technology areas we are pursuing. I think we will put on a good show.

My experience with the Soviets in shows like the Paris Air Show is that they come with a big exhibit, but sometimes it doesn't quite come together. Undoubtedly, they will have a big exhibit here, but I think we will have a better one.

Mr. NELSON. In the preparation, are you satisfied with the coordination between the Government part and the non-Government part?

Mr. BEGGS. Yes, sir, I am.

Mr. NELSON. A while ago, you mentioned about the geosync orbit and the technology advances to solve the problem of crowding. And yet we have a cancellation of 30/20 communications program. Can you explain how you square that?

Mr. BEGGS. We have a cancellation of the satellite program, an issue which is under close examination in the Congress. We have gone back to the industry to examine what we need to do to bring that technology into practical reality. I think we are making progress there—that is, we on our part. I know you are making progress up here. But we did not, of course, suggest the elimination of the technology work in the 30/20. I think the work we are doing is very good, and it will result in solving the essential technical problems to using that part of the spectrum. Of course, we have got to come to grips with whether we go forward to prove that concept by flying an experimental or demonstration satellite.

One way or the other, we will do that; I am convinced of that. Either we will do it through a cooperative program with the industry, or we will do it some other way, but I think it will be done. The proposal we made this year in the budgetary submittal did propose that we delay that decision, but I don't think it obviates the possibility of having such a demonstration satellite in the future.

Mr. NELSON. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

Do you believe that the developing nations and the rest of the world are viewing this Unispace Conference as a political conference as well as a technical conference?

Mr. BEGGS. I do. Yes, sir.

Mr. FLIPPO. And on these political issues, it appears that our position is that this is a technical conference and not a political conference, and so we apparently hope to keep the political issues off the agenda. Is that an accurate observation?

Mr. BEGGS. No, I think, Mr. Chairman, we are probably resigned to the fact that they will get on the agenda, at least to some degree.

Mr. FLIPPO. Do we have in the preparation papers, background papers to which you referred earlier, are you making preparation for those political issues?

Mr. BEGGS. Yes, we are.

Mr. FLIPPO. So do you have a fallback position in the event we are unable to keep them off the agenda?

Mr. BEGGS. We do. Our hope is that these political issues will not become overly contentious in the conference. In one sense, it is a compliment to us that the developing nations bring up these issues.

I think their view on this is that we are an open society that they can try to influence. I think this is a compliment.

At the same time, I think we have certain positions which are based upon realities such as the use of the frequency spectrum and the synchronous orbit, which are reasonable and logical positions to take. Mr. Brown made a very key point when he said we ought to try—and I agree with this—to explain to them why it is we have that position.

Mr. FLIPPO. Let me see if I can clarify one thing in regard to the delegates. Are you prepared to introduce a list into the record of the delegates at this time?

Mr. BEGGS. No, sir, Mr. Chairman, I am not. I think we would be prepared and we will be prepared in a few days. The problem right now is simply in contacting all of the members who have been selected to insure that they can come.

Mr. FLIPPO. I understand.

Well, I would like to thank you both, and all of our witnesses, for your testimony here today. We very much appreciate the opportunity to review the preparation for this. You can understand our concern due to the lateness of some of the preparations or our concept of some of those preparations, and I think you know that this committee stands ready to contribute in any way that we can to the successful mission. Thank you very much.

Mr. BEGGS. Yes, sir, you always have, and we appreciate it.

Mr. FLIPPO. Thank you very much.

[Whereupon, at 3:06 p.m., the subcommittee recessed, to reconvene at the call of the Chair.]

# APPENDIX

## New Administration Space Policy Should Be Grounded

The **Speaker** pro tempore. Under a previous order of the House, the gentleman from California (Mr. **Brown**) is recognized for 30 minutes.

Mr. **Brown** of California. Mr. Speaker, for some time I have been calling for leadership on the part of the administration in the establishment of a bold and aggressive space policy for this Nation. Under President Jimmy Carter, and again under President Ronald Reagan, I introduced legislation to establish a National Space Policy in the hopes of promoting the development of a coherent, long-range national space policy. But the newly announced National Space Policy, released on July 4, 1982, by the President at the landing of the final test flight of the shuttle, can be said at best to be a "treading water" policy, and at worst, and more accurately stated, a strictly militarily inspired space policy, which neglects the civilian economic and technological needs of the Nation.

The heavy-handed priority placed on the military uses of space comes as no surprise; but the blatant and unabashed use of the civilian space agency (the National Aeronautics and Space Administration—NASA) for Department of Defense purposes is unprecedented and a shocking departure from the past. With the growing use of the space shuttle for national security missions, NASA, as has been said before, will operate much like a trucking agency for the Pentagon.

Sadly, this new space policy merely articulates what has been feared to be this administration's policy in regard to space programs. Funding for DOD space programs for the first time this year is equal to NASA's entire budget. In future years, defense spending in space is scheduled to exceed NASA spending while NASA will spend a significant portion of its budget on military applications.

What is left of the space program when the military emphasis is accounted for is a shrunken and, if we are lucky, a static space program. The benefits provided this country economically through space technology spin-offs, through jobs, and through improvements throughout sectors of our society—spanning agriculture, communications, medicine, energy—are unparallelled in any other Federal programs. To turn our back on the fundamental economic strength represented by our country's scientific leadership in the name of national security is, in my view, a form of hypocrisy. It is also bad economic policy.

Mr. Speaker, some of my colleagues may call me harsh, overreactive, or just plain wrong. A casual reader of the space policy will note correctly that there are provisions in the policy for a civil space program along with the space transportation program and the national security space program. But surely program funding is a better way than policy statements to determine where the administration's priorities lie. And if this year's budget debate is any indication, the administration's priority is in military uses of space.

Indicative of the new emphasis on the military uses of space is the choice of the Chairman for the Senior Interagency Group on Space (SIG) announced in the Space Policy on July 4. The SIG is established "* * * to provide a forum to all Federal agencies for their policy views, to review and advise on proposed changes to national space policy, and to provide for orderly and rapid referral of space policy issues to the President * * *." Space policy issues will be referred to the President by its chairman, the Assistant to the President for National Security Affairs. The Administrator of the National Aeronautics and Space Administration is listed as a member of SIG. There is no doubt of the military bias for the uses of outer space.

I was as proud as any American on our latest launch and landing of the Space Shuttle. But if the defense establishment takes over the Shuttle, as it is likely to, can risking the rest of the space program be justified in the name of national security? The threat of closing a superb laboratory such as the Jet Propulsion Laboratory in California or the Lewis Laboratory has been floated as a possible way of off-setting the budget cuts to protect the Shuttle. The Venus orbiting imaging radar project was canceled and the Galileo Jupiter mission is not assured. Cuts in research and analysis have hit the planetary sciences hardest although the feared and rumored cancellation by the administration of the planetary programs did not occur.

Perhaps the cuts in the planetary program indicate best where the administration's priorities are and where it has gone wrong. Despite its past successes, and the inspiration and national pride this program fosters, the planetary program is in serious trouble and is getting no better. There were 38 lunar and planetary launches in the 1960's, 14 in the 1970's, and, with the cancellation of the Venus orbiting imaging radar, 1 approved mission for the 1980's. In 5 years there has been no new program successfully initiated. Adjusting for inflation, the fiscal year 1983 budget for planetary programs is two-thirds the expenditures of 5 years ago.

But cutbacks in programs do not reflect the whole story with regard to the President's space policy. Clearly lacking in the policy is an aggressive high-challenge space engineering initiative such as a permanent space station operating in low Earth orbit. The omission is a perplexing one as such a space station has been considered a logical next step in our space efforts. However, this type of activity will not just happen by itself. It will take the kind of commitment and vision that a space policy should provide and which was not provided in this new policy. The Administrator of NASA, James Beggs, was surely disappointed in the lack of any mention of a space station. Only 10 days before the President announced his policy, Mr. Beggs, in a speech in Michigan said:

"I believe that our next logical step is to establish a permanent manned presence in low-earth orbit. This can be done by developing a manned space station * * * We think that such a station could be built and placed in orbit by 1990 * * * Now that we have the Space Shuttle, we owe it to the Nation to make optimum use of this new capability * * * In fact, the Shuttle program was originally conceived to include a space station."

It is difficult to imagine an initiative such as this one being carried out under the low-keyed space policy.

Similarly lacking was any initiative regarding the exploitation of our satellite capabilities. On the contrary, the administration has in the past stated its intention of transferring the Landsat program to the private sector while failing to provide any plan for accomplishing this objective. I am not convinced that the administration's goal to transfer Landsat is a reasonable one.

I feel strongly that there is an important role for the Government to play in the area of remote sensing. I offer the conclusions and recommendations of the House Subcommittee on Space Science and Applications calling for a global resource information system as an example. Solutions to many global concerns such as threats to the ozone layer, the carbon dioxide problem, and global air and water pollution, as well as global mineral and energy exploration would benefit from the existence of such a system. Some of these objectives might be met by involvement of the private sector as emphasized in the President's space policy. But others, such as observation of the ozone layer, or the carbon dioxide problem would most appropriately be the responsibility of the Federal Government.

Much as I regret having to state it in such terms, this administration's space policy can be likened to early European imperialism, where economic exploitation is achieved by the use of superior technology, and guaranteed by the use of force, rather than cooperation. Such a policy cannot work in a world where new generations of technology develop every 10 years. The United States cannot be sure of its technological superiority, although we generally see a correlation between where we spend our money and where we get results.

We are spending our money on weapons systems and other national security projects, while cutting our support for civilian uses of space. Two results are likely. First, increased tensions and an accelerated arms race, and second, a decline in our economic posture, with a loss of markets to our economic competitors.

Mr. Speaker, it does not have to be this way. We can keep and strengthen the measures to keep the arms race out of space. We can negotiate an anti-satellite warfare treaty, rather than unilaterally try to dominate space militarily. We can continue to lead the world technologically in the peaceful uses of space. And finally, we could show a touch of greatness, as befits a great power, in sharing this wealth of knowledge with others in the pursuit of human progress.

## UNISPACE '82 AND THE MILITARIZATION OF SPACE

(By Hon. George E. Brown, Jr.)

● Mr. **BROWN** of California. Mr. Speaker, as the topic of nuclear arms control and disarmament again move into the center stage of public debate, it is useful for us to look down the road in the direction we are heading. One of those roads is the increasing militarization, or, even more important, the "weaponization" of space.

There are two major United Nations conferences this summer. The first, to begin in a little more than a week in New York, is the U.N. Special Session on Disarmament. The second to begin this August in Vienna is the United Nations Conference on the Peaceful Uses and Exploration of Outer Space, called Unispace '82. Both conferences deal with the future of the human race on this planet. Both conferences are overshadowed by the escalating arms race between the United States and the U.S.S.R. And in both conferences, the United States is apparently determined to avoid multilateral discussions and innovative proposals for global cooperation.

Mr. Speaker, I fear that at each of these conferences, the United States will, by its public posture and by its actions at home, exacerbate the fears of U.S. military intentions. There is fear, for example, that the United States will seek to modify or ignore already ratified nuclear weapons treaties—such as the Outer Space Treaty and the ABM Treaty. There is fear, fortunately somewhat allayed by President Reagan's recent remarks, that the United States will disregard the SALT II Treaty, which has been signed but not ratified by the United States. There is fear, in short, of war—which will inevitably be a nuclear war.

The militarization of space in the United States is symbolized by the decline in the NASA budget, with massive increases in the military space budget. New weapons systems for space are being developed, and while their deployment would probably violate existing treaties, we are accelerating their development. Worldwide opinion calls for an end to this madness, yet the United States fails to heed it, much less use this opportunity to press for effective arms-control agreements.

I could go on, but I will stop at this point. I am inserting in the CONGRESSIONAL RECORD two articles which describe both the militarization of NASA, and the politics around the Unispace '82 conference. I recommend each to my colleagues.

[From the Christian Science Monitor, May 26, 1982]

## SPACE RACE TAKES MILITARY TURN

(By Brad Knickerbocker)

WASHINGTON.—As the US space program moves through the 1980's, it will increasingly become a military venture.

This pleases some in Congress who are urging the Pentagon to do even more with space lasers and other "Star Wars" weaponry. But some, including former astronaut Harrison Schmitt (now a Republican senator from New Mexico), are concerned that this may come at the expense of other scientific space efforts.

Senator Schmitt and like-minded legislators may not be able to reverse the inevitable militarization of space, particularly with the success of the space shuttle. But they did win a significant victory recently when a Senate authorizing committee voted to make the Pentagon pay its own way for future military launches and payloads carried into space. In the coming year, that will amount to $409 million, a sum that originally was included in the National Aeronautics and Space Administration (NASA) budget but now must be borne by the Defense Department.

From the launching of the first Soviet sputnik to the reusable Space Transportation System, as the American shuttle is called, much of both countries' efforts in space has been directed at military advancement. But in recent years, this has accelerated just as détente has given way to greater superpower confrontation.

The Soviet Union, according to Pentagon officials, is several years ahead of the United States in developing a space-based laser weapon that could threaten American satellites and ballistic missiles. The U.S. also is pushing ahead with such weaponry, but not as fast as some would like.

In a classified report last month, the General Accounting Office said directed-energy technology (involving laser, particle, and microwave beams) "may revolutionize military strategy, tactics, and doctrine." It urged the Pentagon to acelerate its development of laser weapons.

Many top Air Force officials are playing down space weaponry, however. Meeting with Pentagon reporters over breakfast recently, the Air Force's research director, Lt. Gen. Kelly Burke, cited the great technological problems presented by building, transporting, and accurately using space lasers. He noted the antisatellite missile that the Air Force soon will test fire from high-flying jet fighters as a better system for the near future.

Overall, however, the military aspects of the U.S. space effort are gaining as nonmilitary research projects account for less and less of NASA's spending.

"Whereas NASA's scientific programs were a full 36 percent of the research and development budgets in 1979 and 1980, they constitute only 28 percent of the proposed 1983 budget," Senator Schmitt complained recently. "Since 1980 the aeronautics budget of NASA has decreased by over 40 percent in constant dollars.

"The proposed fiscal year 1983 budget contains many programs only because they are of direct interest to the Department of Defense, while eliminating 12 major systems technology programs which would support a private aeronautics industry hard hit by foreign competition."

Since 1979, Schmitt points out, NASA has canceled its obligation to supply a spacecraft for the International Solar Polar Mission, plans for a Venus mapping mission (although a modest mission now is being studied), and a rendezvous with Halley's Comet in 1986.

In criticizing the growing military use of the space shuttle, Schmitt says, "The DOD should not have to be subsidized at the expense of our country's civil aeronautics and space programs."

However, DOD support has been crucial to shuttle development all along and shuttle planning has always including the military applications.

According to a recent GAO report, the Pentagon will be the prime passenger aboard nearly half the shuttle flights through 1984, 114 out of 234.

"This is bad news for those who are concerned over cutbacks in NASA's space science activities," says Sen. William Proxmire (D) of Wisconsin. "It means that more and more of each NASA budget will be spent on defense-related activities and less and less will be spent on civilian science."

It was because of this that the Senate voted earlier this month to stop "the free ride for the Pentagon," as Senator Schmitt puts it.

This is not likely to slow down the Defense Department's increasing role in space activities, however. In addition to antisatellite programs, defense planners are working on space-based communications and navigation systems, nuclear detection devices, and enemy missile warning capabilities.

The fourth flight of the space shuttle, scheduled for June 27, will include a military payload.

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[From the Stars and Stripes—the National Tribune, May 13, 1982]

## UNISPACE '82—PROMISES AND PROBLEMS

(By Jane A. Willenz)

Unispace '82. It sounds like a sequel to Star Wars or a new science fiction takeoff into the space age. No one seems to know much about it, perhaps because it is not a media event. Nor is it likely to be. That's unfortunate because more people should know about it.

Unispace '82 is the Second-United Nations Conference on the Exploration and Peaceful uses of Outer Space, which will be held in Vienna, Austria, August 9–21. Nearly 140 nations from this planet are planning to participate in the Conference which is the second of its kind, the first being in 1968.

One cannot help but wonder why the exploration of outerspace and its implications have so receded into the background of public consciousness.

Yes, every new launching of a space vehicle gets its share of media coverage. There is a flurry; lots of Americans are glued to their TV sets and a collective sigh of relief is heard when the space craft returns safely, particularly when it is manned.

But the gorgeous wonder of it all somehow is muted. The awesome possibilities for good and evil are not a subject of much public debate and certainly of little private conjecture.

Maybe we are jaded, or maybe we are just frightened; there is already so much to be frightened about these days. The saber rattling of the Reagan Administration, and the "small" adventure in the South Atlantic which is a powderkeg for the very fragile nobelligerency state of a good part of the world, have raised the ante of worry.

The United States is sending a high level delegation to Vienna as well as mounting an exhibit. Ambassador Gerald B. Helman of the U.S. Dept. of State is coordinating the American effort, while James Beggs, the head of NASA, will lead the delegation.

Americans see the Conference as primarily educational rather then decisionmaking—a forum for stock taking—to review and share information on what has worked and what hasn't worked.

The agenda will cover three major areas: (1) State of space science and technology, (2) Applications of space science and technology and (3) International cooperation and the role of the UN.

Since third world countries are very interested in extending their capabilities in space, they have shown a strong interest in the Conference. They want more of the space action and many are throwing heavy resources into trying to get it. The Conference will give them all kinds of information that will assist them in launching specific projects.

The United States, according to the State Dept. spokesman, is committed to providing opportunities for international cooperation of space technology. And according to NASA, international cooperation has always been a way of life there; they claim that there hasn't been any major program at NASA without it.

According to the NASA philosophy, the United States wants to cooperate with all countries and to help provide the benefits that are derived from outer space technology, with all people.

One would assume from this beneficient approach from the U.S., the Unispace '82 is a promising event. It turns out there is much discontent.

There is criticism of the U.S. to joining the Conference late and some claim is not providing the kind of exhibit it is capable of providing.

The Third World countries, which are not monolithic, are apprehensive about the uses of space and how that will affect their sovereignty.

The NGO's—non-governmental organization—are preparing for a parallel conference at Vienna. It is called the "NGOs at Unispace '82", and its theme is "peaceful development through space."

The NGOs make no bones about their conference being a political one. They feel that Unispace itself must deal with the political issues which are not on the agenda. They point out that the Third World considers space exploration and technology development a new form of economic imperialism of the "have" nations against the "have nots."

Among the issues that the NGOs claim are on the hidden agenda of Unispace and which will be on the NGO agenda are: Energy from space; Environment and Space, Geostationary Orbits, Remote Sensing; and Transfer Technology.

And most important of all, the NGO's are concerned about the "militarization" of space. None of these issues will be taken up substantively by the Unispace Conference itself, although they may be touched upon.

The NGO's probably mirror many of the concerns of the Third World countries. For example, the technology of remote sensing which is very sophisticated and not within the capability of most Third World countries. raises many thorny issues. Who controls the data which is sensed by the satellite?

While the data is theoretically open to all, only the most advanced nations have the technology to extract that data. So "openess" is quite meaningless for those who can't do anything with the data.

Apprehension and fear mark the third world's views of the pioneering efforts into space. After all, they have had considerable experience with the users that mankind has put to scientific discovery.

Unhappily, much of their experiences have been negative. Exploration has often meant exploitation for them. They are struggling to catch up. And there are many nations in the Third World which do have a variety of capabilities in the space technology field.

In terms of what space technology can do, the Third World nations have an incredible amount to gain. The U.S.'s AID Agency has performed minor miracles in demonstrating how some of that technology can assist an underdeveloped nation help itself—in rural development, in communication, in education, in institution building, in developing power sources.

Of course, these uses of space exploration and technology are welcome to Third World countries. But they worry about the other possibilities which they see as threatening their sovereignty as well as their security.

The uses of outer space are governed by the Outer Space Treaty. The U.S. position is that it is developing the peaceful uses of outer space in a fashion consistent with the UN Charter which includes maintenance of U.S. security.

This is scary to the less developed nations, it smacks of militaristic use of outer space. The U.S. denies this; but asserts its rights under the Charter to capitalize on its technology to maximize its security.

Even if the U.S. is de jure within the boundaries of the UN charter, Third World nations are wary of the potential of space technology for military uses and/or domination.

Unispace '82 will not deal with this thorny issue, if it can avoid it but the parallel NGO conference will. It is useful that there be a forum for discussions of the fears of the less technologically-advanced nations. And it is important that the U.S. and the other technologically capable countries listen to those concerns and try to deal with them.

Perhaps the wonder and optimism of space exploration and development will return. This is the hope of the U.S. conference coordinators.

The potential for benefitting mankind through the marvelous breakthroughs in space science is unlimited. Wouldn't it be wonderful if the political problems would go away?

But, they won't unless nations will attack them with the same imagination and commitment that they approach scientific exploration. That indeed, is the main challenge to Unispace '82, whether it is on the official agenda or not.

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## Study on the implications of establishing an international satellite monitoring agency

## Report of the Secretary-General

1. By resolution 33/71 J of 14 December 1978 the General Assembly requested the Secretary-General to undertake, with the assistance of a group of qualified governmental experts, a study on the technical, legal and financial implications of establishing an international satellite monitoring agency. Pursuant to the above resolution. the Secretary-General submitted to the General Assembly at its thirty-fourth session a report containing the conclusions of the Group of Experts, as a result of which the General Assembly, in resolution 34/83 E adopted on 11 December 1979, requested the Secretary-General to carry out an in-depth study on the subject, and to submit thereon a comprehensive report in time for the General Assembly to take a decision at its second special session on disarmament in 1982. It also drew attention to the fact that the study should be submitted no later than June 1981 to the Preparatory Committee for the Second Special Session of the General Assembly Devoted to Disarmament.

2. The Group of Experts submitted its study to the Secretary-General on 10 June 1981. The study is annexed to the present document.

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## Study prepared by the Group of Governmental Experts on the implications of establishing an international satellite monitoring agency

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## FOREWORD

At the first special session of the General Assembly devoted to disarmament, held in the spring of 1978, the delegation of France submitted a memorandum in which it proposed the establishment of an international satellite monitoring agency by means of which the use of observation satellites within the framework of disarmament would be placed at the service of the international community. The General Assembly noted the proposal in paragraph 125 (d) of the Final Document adopted at the end of its special session and at its thirty-third regular session it adopted resolution 33/71 J in which, *inter alia*, it requested the Secretary-General to undertake, with the assistance of qualified governmental experts, a study on the technical, legal and financial implications of establishing an international satellite monitoring agency.

In pursuance of that resolution the Secretary-General appointed a group of experts, who reached preliminary conclusions that were submitted to the General Assembly at its thirty-fourth session. Following the recommendations of the Group, the General Assembly adopted resolution 34/83 E, in which it requested the Secretary-General to carry out an in-depth study with the assistance of the Group of Experts previously constituted, and to submit a comprehensive report on the subject in time for the General Assembly to take a decision at its special session devoted to disarmament in 1982. The resolution also drew attention to the fact that, accordingly, the study should be submitted no later than June 1981 to the Preparatory Committee for the second special session.

As the result of sustained and intensive efforts the Group of Experts have been able to adopt a unanimous report covering all aspects of the area under consideration.

The Secretary-General wishes to thank the experts for their unanimous report, which in pursuance of resolution 34/83 E he hereby submits to the General Assembly for its consideration. It should be noted that the observations and recommendations contained in the report are those of the experts. In this connexion, the Secretary-General would like to point out that in the complex field of disarmament matters, in many instances he is not in a position to pass judgement on all aspects of the work accomplished by the experts.

Kurt WALDHEIM
Secretary-General

/...

## LETTER OF TRANSMITTAL

/Original: French/
/10 June 1981/

Sir,

I have the honour to submit herewith a unanimous report containing the in-depth study on the technical, legal and financial implications of establishing an international satellite monitoring agency, which was prepared in pursuance of General Assembly resolution 34/83 E.

The list of experts in this group, which you set up on the basis of nominations from their respective Governments, can be found in annex I of this report. I should like to point out here that, since the group had to consider three types of implications which required quite different specialized knowledge, many of the experts were assisted by technical or legal consultants who made a substantial contribution to the preparation of this report.

A draft of the report was prepared at sessions held at Geneva from 4 to 8 February 1980, 19 to 30 May 1980 and 8 to 19 September 1980 and reflected the preliminary conclusions of the group submitted to the General Assembly in document A/34/540 of 18 October 1980. The Group adopted the report in its present form at its last session, held at Geneva from 16 to 20 February 1981.

The Group wishes to express its gratitude to the International Telecommunication Union (ITU), the World Meteorological Organization (WMO) and the International Atomic Energy Agency (IAEA) for their help in providing valuable information and useful documentation.

The Group also wishes to thank the Secretariat staff and consultants for their valuable assistance.

In my capacity as chairman of the Group of experts, I have been requested to transmit to you its unanimous report.

Accept, Sir, the assurances of my highest consideration.

(Signed) Hubert G. BORTZMEYER
Chairman of the Group of
Governmental Experts appointed
to study the implications of
establishing an international
satellite monitoring agency

Mr. Kurt Waldheim
Secretary-General of the United Nations
New York, N.Y. 10017

/...

## PREFACE

### A. Background

1. At the First Special Session of the General Assembly devoted to Disarmament, held in New York in May-June 1978, the delegation of France proposed, in a note verbale (A/S-10/AC.1/7) to which a memorandum was attached, the establishment of an international satellite monitoring agency (ISMA). The General Assembly noted the proposal in paragraph 125 (d) of the Final Document adopted at the end of the Special Session and deferred study thereof until its thirty-third regular session.

2. The memorandum submitted by France pointed out that the technological progress achieved in the field of observation satellites constituted a new development in the management of international affairs and it proposed that "within the framework of current disarmament efforts, this new monitoring method should be placed at the service of the international community". This memorandum noted that surveillance satellites have already attained a very high level of performance in their observation capability and now play an important role in the verification of certain bilateral arms-control agreements and in the monitoring of some crises. It further recalled that many United Nations resolutions have stressed the need for disarmament agreements to be subjected to effective international verification and that the use of observation satellites for purposes of verification could help reduce the difficulties in verifying compliance with such agreements and thus advance the cause of disarmament. Finally, it noted that observation satellites could contribute to effective management of crises situations and thereby strengthen international confidence and security.

3. Finally, the memorandum submitted by France outlined various important elements of an ISMA, including its guiding principles, functions, statute, technical resources and financing that should be considered.

### B. Mandate and work of the Group of Experts

4. At its thirty-third regular session, the General Assembly, "convinced of the important contribution which such technology can make to the solution of monitoring problems, taking into account, in particular, the need to provide for international measures which are non-discriminatory and do not constitute interference in the internal affairs of States", adopted resolution 33/71 J, requesting the Secretary-General to obtain the views of Member States on the proposals contained in document A/S-10/AC.1/7 and to undertake, with the assistance of qualified governmental experts, a study on the technical, legal and financial implications of establishing an international satellite monitoring agency (ISMA). 1/ The Secretary-General was further requested "to report to the Assembly at its thirty-fourth regular session on the replies received from Governments and the preliminary conclusions of the Group of Experts".

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1/ The term "international satellite monitoring agency" (ISMA) has been used in this report without prejudging the nature of the future organizational structure.

5. In pursuance of this resolution and upon nomination by their Governments, the Secretary-General appointed a Group of Experts which met twice in Geneva, from 11-15 June and from 10-14 September 1979 under the chairmanship of Mr. Bortzmeyer (France). The list of experts is to be found in Annex I. The Group reached preliminary conclusions which the Secretary-General submitted to the thirty-fourth session of the General Assembly as document A/34/540 of 18 October 1979. The views of Member States on the French proposal were also submitted to the General Assembly in document A/34/37. Following the recommendations of the Group of Experts, the General Assembly adopted resolution A/34/83 E in which it requested the Secretary-General to carry out an in-depth study with the assistance of the Group of Experts previously constituted, and to submit a comprehensive report on the subject in time for the General Assembly to take a decision at its special session devoted to disarmament in 1982.

6. In pursuance of this resolution, the Group, the composition of which remained the same, met four times in Geneva from 4-8 February 1980, 19-30 May 1980, 8-19 September 1980 and 16-20 February 1981. For its work under the second mandate it unanimously re-elected Mr. H. Bortzmeyer (France) as Chairman. The valuable assistance of the legal consultant, Dr. I. Vlasic, Professor of Law, McGill University in Montreal (Institute of Air and Space Law), was most appreciated by the Group. The Group equally appreciated the valuable assistance of the technical consultant Dr. B. Jasani, Stockholm International Peace Research Institute (SIPRI). Mr. Janssens, Secretary-General of EUROSAT, was invited by the Group to apprise it of the conclusions of a Seminar convened by the Pugwash Movement on satellite monitoring of arms control and disarmament agreements. Mr. R. Perry of the Rand Corporation was also invited to give the Group, in his personal capacity, the benefit of his experience relevant to the monitoring of arms control agreements by satellite.

7. For its work under both mandates, the United Nations Centre for Disarmament appointed Mrs. Waldheim-Natural as Secretary of the Group. The United Nations Outer Space Affairs Division was represented alternatively by Mr. L. Perek and Mr. N. Jasentuliyana.

8. The Group also received useful assistance in the form of information from representatives of the International Telecommunication Union (ITU), the World Meteorological Organization (WMO) and the International Atomic Energy Agency (IAEA).

9. The Group wishes to express its gratitude to all those mentioned above who contributed towards making this report possible.

10. At the final session in February 1981, the Group of Experts unanimously adopted this report on the technical, legal and financial implications of establishing an ISMA.

11. The present report is submitted to the Secretary-General in accordance with resolution A/34/83 E so that it may be discussed at the Second Special Session of the General Assembly devoted to disarmament. The Group expressed the hope that it will be considered in the context of other proposals and studies aimed at promoting the cause of disarmament and that it will contribute towards implementing the Programme of Action contained in the Final Document of the First Special Session of the General Assembly devoted to disarmament.

/...

## INTRODUCTION

12. Under its first mandate (see para. 4 above), the Group gave careful consideration to the proposal to establish an ISMA as outlined in the above-mentioned memorandum submitted by France to the Special Session of the General Assembly devoted to disarmament contained in document A/S-10/AC.1/7.

13. In its preliminary conclusions, referred to in paragraph 5 above, the Group agreed as follows:

> "[it] recognized the valuable contribution which monitoring by satellites could make to the verification of certain parts or types of arms control and disarmament agreements. This contribution from satellites to the verification process must not in general be seen as excluding other means of verification. The Group also appreciated the positive role that satellite monitoring could play in preventing or settling crises in various parts of the world and thus contributing to confidence-building among nations. The Group considered the gradual approach to the establishment of an international satellite monitoring agency technically feasible and saw in it a way to limit and control the financial commitments required from the international community. With respect to the legal nature of the agency, it appeared that action would have to be taken to ensure its independence, which would constitute an essential guarantee for the objectivity of its analyses".

14. In order to fulfil its second mandate (see para. 5), the Group considered in detail the technical, legal and financial implications of the establishment of an ISMA.

15. The Group initiated its work by reviewing the state of the art in space technology as it relates to monitoring by satellites. For this purpose the Group used only official government publications and other sources of information publicly available. The Group was aware that this procedure has inherent limitations. It after examined the technical requirements and facilities needed for the establishment and operation of an ISMA, before discussing the possibility of verifying by satellite compliance with existing arms control and disarmament agreements as well as agreements that might be concluded in the future. (A list of existing agreements and the texts of their verification provisions appear in annex V). The Group continued its work with an in-depth study of the legal implications of observation by satellite, the issues relating to the establishment, structure and functioning of an ISMA. The Group also examined the financial implications of the various phases in the evolution of an ISMA and endeavoured to give cost indications for the setting up of a data processing and interpretation centre (Phase I), the establishment of ground receiving stations (Phase II) and the establishment of its own space segment as a supplement to national systems (Phase III).

## CONCLUSIONS

16. The Group recognized the valuable contribution which monitoring by satellites could make to the verification of compliance with certain arms control and disarmament agreements. It further recognized the positive role that satellite monitoring could play in preventing or settling international crises and thus contribute to confidence-building among nations.

17. From a technical point of view observations from satellites for the purpose of information gathering related to verification of compliance with treaties and for crisis monitoring is both possible and feasible. The technical facilities for an International Satellite Monitoring Agency (ISMA), including the satellites necessary to carry out the needed missions, could be acquired in stages: for instance, Phase I could comprise only an image processing and interpretation centre, Phase II could comprise data-receiving stations that could receive appropriate data from observation satellites of various States and in Phase III where the Agency could have its own space segment comprising a number of satellites.

18. From a legal point of view, there is no provision in international law, including space law, that would entail a prohibition for an international governmental organization such as an ISMA to carry out monitoring activities by satellites.

19. As regards the financial implications, a variety of technical options are possible, leading to a broad range in cost estimates; a summary of the estimates made by the Group is to be found in the body of the report. Whatever the assumptions on which the estimates are based, even in Phase III, which is the most complete and most expensive phase, an ISMA would cost the international community each year well under 1 per cent of the total annual expenditure on armaments.

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## CHAPTER ONE: TECHNICAL IMPLICATIONS [*]

### I. BACKGROUND

20. During the past decade, increasing use has been made of military satellites, for example, to identify military targets, to predict weather conditions, to ensure communications and to facilitate navigation. At the same time civilian satellites have been placed into orbit. One of the main roles of several types of civilian satellites during this period has been to identify and map the natural resources of the Earth.

21. While military satellites are currently capable of contributing significantly to the verification of the implementation of arms control and disarmament agreements, the development of the capability of civilian satellites could in the future also make them useful for such a purpose. The only two countries which today possess the necessary space technology for gathering data pertaining to military installations and activities and thus relevant to the verification of arms control agreements and to crisis monitoring are the United States and the Soviet Union, but a number of other countries are also developing the technological capability.

22. The following sections contain, first, a world-wide review of the present state of the technology of manned satellites, civilian and military satellite systems for remote sensing and image processing and interpretation centres (Section A); second a description of the technical mission and data requirements for monitoring of compliance with arms control and disarmament agreements and for crisis monitoring (Section B); and last, a study of the technical elements with which the Agency could be endowed in three phases (Section C).

### (A) Present state of the technology of civilian and military satellite systems for remote sensing including manned satellites

23. For Earth observation from space, a satellite's orbit and its sensor payload are selected depending on the type of information needed. Sensors observe and record images of the Earth's surface and the atmosphere by detecting radiated or reflected electromagnetic radiation. The data collected by the sensors are either recorded on films or by tape recorders. The exposed film can either be brought back to Earth or it can be developed and scanned on board the satellite by electronic devices or directly transmitted to Earth via telemetry links. In the latter case, the resulting electrical signals are transmitted by radio to a receiving ground station when the satellite is within radio-visibility. A satellite data receiving station thus comprises antennae, receivers, data pre-processing, storage and normally data analysis equipment.

24. In a satellite verification/observation system, an essential element is an imaging sensor which may be characterized by various technical parameters like image geometry, noise (detector uncertainty), spectral, radiometric, and spatial resolution. The spatial resolving capability, or in short the resolution is the ability of the sensor to record small details in the scene. The question of how small details or objects can be perceived in an image made with the sensor is, however, a complicated one and depends both upon the spatial resolution capacity of the sensor itself and the characteristics of the scene (object shape and size, object contrast, etc.). The resolution capacity of the sensor (i.e., the resolving power of the sensor) may be

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[*] A glossary of technical terms used in this report and a list of abbreviations can be found in Annex II and Annex III respectively.

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uniquely defined in various ways, e.g., as the ability to estimate the position of a very small object or as the minimum distance between two identical small objects when these can still be distinguished as two separate objects. The resolving power of the scanning sensors depends both upon the IFOV (Instantaneous Field of View), the scanning pattern and the noise of the sensor. The IFOV is equal to the size of the spot on ground "seen" by one particular point in the image or seen by a scanning sensor at the instant of observation. The actual resolution (ground resolution) in a visual image is contrast dependent and for a contrast ratio of 2:1 it is approximately equal to 2-2.4 times the IFOV and that for 1000:1 it is approximately equal to 1.4-1.6 times the IFOV. For comparing various sensors the ground resolution (referred to as resolution in this report) is used. All the figures assume a "standard scene" having a contrast ratio of 2.5:1. It should, however, be underlined that there is no scientific agreement on the definition of "resolution" of different sensors due to the influence of many factors. Among these, lighting conditions, configuration, size and the distribution of objects and atmospheric effects should be mentioned. For the purpose of this report, the Group used certain figures for ground resolution and the figures indicated below should thus only be taken as relative figures intended to give an indication of sensor quality needed for a particular task. In this report IFOV figure is used as the equivalent sensor resolution both for photographic and other sensors assuming that the ratio between IFOV and ground resolution is approximately two.

25. Resolutions required of a sensor to detect, recognize, identify and describe various targets are indicated in Table 1. Two types of mission are used for military surveillance: (1) area surveillance using resolution in the range of 3-5 metres and (2) close-look using resolution of 0.5-2 metres. Resolutions of between 0.15 and 0.3 m are obtainable from sensors on military satellites, which suggests that these satellites are capable of performing most of the tasks indicated in Table 1.

26. Military surveillance satellites are not only capable of contributing to the verification process of implementation of arms control and disarmament agreements but they have become an important source of information for this process thus providing a means of inspection which is not based on the idea of "on-site inspection". The use of satellites has already become embodied in arms control treaties such as SALT I and II.

27. Military surveillance satellites can be divided into five groups, namely, photographic and electronic reconnaissance satellites, early-warning, ocean surveillance and nuclear explosion detection satellites. Usually, the photographic reconnaissance satellites orbit with their perigee heights between 150 km and 250 km.

28. Initially these satellites had two missions: the first was to scan a large area of a particular country for objects of potential interest, and the second was to re-photograph areas of particular interest, using a high-resolution camera system. In the latter case, at the end of the mission, a capsule containing the film may be ejected from the spacecraft and recovered either from sea or in mid-air. In some cases the satellite itself is recovered.

29. A satellite system, in which one type of satellite identifies potentially interesting areas and another makes detailed studies of them, contains certain disadvantages because a large number of photographs must be taken by the surveillance satellite and because recovery and processing of these cause some delay before satellites with high-resolution camera equipment can be launched. This led to the development of a third type of satellite. This satellite is designed to perform both the area-surveillance and the close-look types of missions. Orbital lifetimes of photographic reconnaissance satellites have increased from eight days to as long

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as two years for some of the more recent satellites. Such satellites carry extra fuel in order to lower their altitudes for close observations or increase the altitudes for area surveillance missions or for longer orbital lives. The other types of observation satellites are generally orbited at altitudes greater than those required for photographic missions (above about 500 km).

30. The fact that satellites provide valuable data on the course of military operations has been amply demonstrated by the increase in the satellite launching rate during periods of conflict in various parts of the world - for example, during the India-Pakistan, Arab-Israeli and Cyprus conflicts in 1971, 1973 and 1974 respectively. Available information seems to suggest that satellites have also monitored the Iran-Iraq conflict in 1980. By increasing the number of satellites or by manoeuvring them, it is possible to scan a certain area more frequently. Using satellites, it is now possible to obtain sufficiently detailed information on military preparations or actual fighting and under present-day conditions it is difficult for activities of this kind to escape observation by satellite, thus extending the use of satellites to another dimension, that of monitoring crisis.

31. In the past decade, major efforts have been made and considerable progress has been achieved in improving the performance of military observation satellites. The performance of civilian satellites has also improved considerably. For example, the return-beam vidicon cameras (RBV) on board the United States Landsat-1 and -2 satellites had resolutions of 80 m IFOV while that on the Landsat-3 has a resolution of 40 m IFOV. While all the three Landsat satellites carried multi-spectral scanners (MSS) with 80 m IFOV, a MSS on the proposed French SPOT satellite is expected to have a 20 m IFOV. A camera on this satellite operating in panchromatic mode is expected to have a 10 m IFOV. The new Landsat-D satellite is expected to carry a new sensor called a thematic mapper with 30 m IFOV. A synthetic aperture radar (SAR) on board the USA ocean surveillance satellite Seasat-1 had a resolution of about 25 m IFOV. On the other hand, an Earth terrain camera on board the USA Skylab manned satellite had a resolution of between 15 and 30 m. It is interesting to note that if some of these sensors were to orbit at an altitude of 200 km rather than at 440 km (Skylab) or 900 km (Landsat), the resolution would approach to that of a camera on board a military area surveillance satellite.

32. Remote sensing of land resources by satellite, which is a by-product of the development of military observation satellites, dates only from 1972 but is now about to enter the operational phase. Major applications of economic importance are: evaluation of crop yields, inventories of land and cultivated areas, determination of the growth of a particular crop, detection of faults and other geological details which are used in discovering ores, identification of fish shoals and other biological resources of the sea, determination of reserves of water in snow layers and of the movement of glaciers, pin-pointing of disasters, etc.

33. Today, the United States and the USSR alone have operational satellite reconnaissance programmes. A third country with an advanced satellite reconnaissance capability is reported to be the People's Republic of China. A number of other countries, such as France, India and Japan, have the potential to develop and launch remote sensing satellites designed for Earth resources survey. The European Space Agency (ESA) has also embarked on remote sensing programmes. The progress of these countries in this field is described briefly in the following sections.

A note of caution should be sounded in this connection since, while information concerning civil remote sensing programmes is freely available, detailed information concerning military satellite reconnaissance programmes is not available.

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(a) United States programme

(i) Military satellites

34. The use of artificial Earth satellites for reconnaissance purposes was recognized in the United States as long ago as 1946, and by 1954 considerable details were worked out on these satellites. In October 1956 the development of the Agena rocket, which has since been the basic launch vehicle for reconnaissance satellites, began.

35. Reconnaissance satellites. The first United States reconnaissance satellite was launched in 1959. These early satellites had relatively short orbital lifetimes of up to about 30 days. The first of the long-lived satellites, launched in 1971, had a lifetime of 152 days which increased to 190 days for some of the subsequent satellites. This satellite is designed to perform both the area-surveillance and the close-look type of mission. The latter mission is fulfilled using a large telescope with a resolution of about 30 cm.

36. The development of a new generation of satellites with orbital life of over two years may have begun in early 1972. The first of these was launched in December 1976 and had a lifetime of 770 days. These satellites are orbited about 50 km higher than the previous satellites (200-250 km) and they transmit photographic images in real-time in digital form.

37. Electronic reconnaissance satellites. Until 1972, electronic reconnaissance satellites were launched independently, but since then they have been put into orbit simultaneously with some photographic reconnaissance satellites. The satellites are ejected from the mother spacecraft into independent sun-synchronous orbits with much greater orbital heights of between 500-1,400 km.

38. These satellites determine the signal characteristics and detection range of radars and they also monitor military radio communications. The sensors on board such satellites also record telemetry-radio signals sent back to the ground from a missile during its test flight to provide information on the performance of the missile. Another application of such satellites in determining the nature of naval vessels is discussed below.

39. Ocean surveillance satellites. The first ocean-surveillance satellite launched in 1976 was designed to monitor locations of surface ships. The satellite carried three small sub-satellites which were placed into near-circular orbits similar to that of the main satellite. The basic technology of having several satellites to monitor electronic signals generated by naval vessels to determine their nature and to determine the direction of ships, was demonstrated in 1971 and again in 1977 by the launching of another set of multiple satellites. On 3 March 1980 another group of three operational marine observation satellites was launched in a similar orbit to that of the earlier satellites. In addition to radio signal detectors the new satellites are equipped with passive sensors for detecting infra-red and microwave radiation.

40. There are plans to build advanced ocean-surveillance systems, consisting of radars for the accurate determination of the positions of surface naval vessels. The first launching with such sensors may be in 1983. With the electronic signals monitored by the earlier satellites and the information from the new ones, a ship could then be identified.

41. *Early-warning satellites*. Early-warning satellites are usually at geosynchronous altitude and are used to detect the launch of ballistic missiles. The total surface observed by the satellites is rapidly scanned with a resolution of about 3 km IFOV. Recently satellites orbiting in geosynchronous orbit perform an additional task: they also monitor the telemetry of ballistic missiles when they are being tested.

42. Under a programme called high-altitude large optics (HALO), new mosaic focal-plane array infra-red detectors are being developed. These will replace the current sensors used on early-warning satellites. The HALO programme includes both studies of large focal plane and light-weight optics, and investigations on adaptive optics. The technique involves correction of image distortions introduced by atmospheric turbulence by selectively modifying properties of the optical system.

43. *Nuclear explosion monitoring satellites*. Twelve nuclear explosion monitoring satellites have been launched by the United States but only three of these are operational today. These, known as Vela satellites, were developed to check violations of the treaty banning nuclear explosions in the atmosphere and in outer space. Unlike what happens in the case of such explosions in the Earth's atmosphere, radiation and fission products from a nuclear explosion in outer space can expand and propagate freely in outer space. However, the presence in space of Van Allen radiation belts and solar flares complicates the detection of radiation by this technique.

44. If a nuclear explosion takes place in the radiation belts, radiation caused by the explosion may not be detected by the detectors on board the satellite, because there is already a very high level of radiation present in the belts. Therefore, to use satellites effectively to verify the observance of the Partial Test Ban Treaty, other techniques are required. A nuclear explosion produces many other phenomena which may possibly be used for the purpose. It is possible that the satellites carry, besides nuclear radiation detectors, optical instruments which would determine the emission spectra of the most abundant chemical elements of the nuclear bomb or its fission products (lithium, uranium, plutonium, barium, and so on). Detectors sensitive to X-rays are also used for detection of nuclear explosions in space.

45. It has been reported that the United States has plans to test nuclear explosion-detection sensors on board a navigation satellite. Initial feasibility of this Integrated Operational Nuclear Detection System (IONDS) was conducted during early 1975.

(ii) *Civilian satellites*

46. *Landsat programme*. The first remote sensing satellite ERTS-1, later named Landsat-1, was placed in orbit by NASA on 23 July 1972 and operated until 6 January 1978. The second satellite, Landsat-2, was placed in orbit on 22 January 1975 and is still operating. The third satellite, Landsat-3 has been in operation since March 1978. The satellites are placed in orbit at a height of about 910 km, and the period is about 103 minutes. The parameters of the orbit were selected to obtain an 18-day cycle for covering the whole world between 81° N and 81° S. The data collected by the satellite sensors is converted into digital form by electronic devices on board the spacecraft and either transmitted to ground stations in real time or recorded on magnetic tapes on board the satellite for transmission at a later time. The main sensors carried on the Landsat satellites are MSS and RBV cameras. The former on Landsat-1 and -2 obtained images in four spectral bands while Landsat-3 has a fifth band in the far infra-red region of the electromagnetic spectrum. This fifth band with a resolution of 240 m IFOV was designed for recording data at night; but a fault developed in this band soon after launching. The RBV system consisted of three television cameras on Landsat-1 and -2 and two panchromatic television cameras on Landsat-3.

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47. The television cameras on Landsat-1 ceased operating two weeks after the satellite was launched. On Landsat-2, no major technical problems arose with the RBV system, but it was not used extensively. Most of the information acquired by Landsat-1 and -2 on land resources was obtained by the MSS system. On Landsat-3, the RBV system was replaced by 40-m resolution panchromatic cameras.

48. Apart from considerable information obtained from Landsat on agriculture, cartography, geology, hydrology and oceanography, it has been reported that some information of a strategic nature, such as roads, railway tracks, airports, depots, etc., may be obtained.

49. The next satellite in the NASA remote-sensing programme will be Landsat-D, the first of a second generation of remote sensing satellites. It is scheduled for launch during 1982. The world coverage cycle will still be in the range of 16 to 19 days. The satellite will be orbited at a lower altitude of 700 km in a circular sun-synchronous orbit. The programme provides for the launching, one year later, of a second identical satellite so that the world coverage cycle will be about nine days.

50. The Landsat-D satellite, which is technically the most advanced satellite in the Landsat series, will be equipped with a MSS with four or five spectral bands, and also with a new seven-band multi-spectral scanner known as the Thematic Mapper with a 30 m IFOV. The improved resolution and the greatly increased volume of data has to be noted.

51. The new satellite will differ from its predecessors in its basic design, which would be modular. Repair or replacement of worn-out systems could be achieved - with the aid of the Space Shuttle, while the satellite is in orbit. The satellite will transmit its data to the ground through the relay satellites in the Tracking and Data Relay Satellite System (TDRSS). Direct transmission to ground stations would be maintained.

52. In view of the technological difficulties encountered in producing the Thematic Mapper and its related systems, there is a possibility that the launching of Landsat-D may be delayed, with the result that continuity in the supply of Landsat data to users may be broken. To ensure continuity of data to users, NASA, together with the National Oceanic and Atmospheric Administration (NOAA), which would administer future operational remote-sensing systems, is reported to be exploring alternatives, including launching of Landsat-3 type satellites (i.e., without the Thematic Mapper).

53. *HCMM programme*. On 25 April 1978, NASA placed in orbit a small remote sensing satellite known as Heat Capacity Mapping Mission (HCMM) equipped with a 2-channel infra-red thermal channel radiometer. The satellite is orbited in a circular sun-synchronous orbit at a height of 620 km, and overflies every area between 85° N and 85° S at least once a day and once a night, at 16-day intervals. The satellite's task is to sense infra-red radiations at the maximum and minimum temperatures of the areas overflown. The HCMM ceased operation in September 1980.

54. Some of the applications of HCMM are:

- classification of geological structures according to their thermal inertia characteristics; detection of surface faults and fractures; possible location of mineral ores;

- measurement of soil moisture;

- surveillance of thawing, which is important for giving warning of flood risks and conserving water resources.

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55. Seasat programme. On 26 June 1978 NASA launched the Seasat-1 satellite in a circular polar orbit at an altitude of about 800 km to study various ocean phenomena. The main sensor was a synthetic aperture radar (SAR) capable of recording data, day and night under all weather conditions.

56. The satellite was also equipped with devices to measure sea roughness, sea-surface wind speed, wave height, terrain characteristics (using a radar altimeter), and sea-surface temperature and humidity (with a passive radiometer).

57. Though operational for only 99 days, the Seasat-1 satellite results have shown the utility of SAR in ocean monitoring.

58. The Skylab remote-sensing programme. The manned Skylab satellite orbited the earth at a height of 425 km carrying a camera for near infra-red photography, a 13-channel multi-spectral device and microwave sensors. The latter provided data which have been useful in improving subsequent remote sensing systems. Of particular interest was the S 190-B camera with which photographs were obtained in black and white and colour with resolutions between 15 and 30 m. Each image covered an area of 109 km$^2$.

59. The Space Shuttle and Spacelab. The first launchings of the re-usable launcher known as the Shuttle is expected to take place in 1981. It is planned that in 1982 this vehicle will be able to carry into space the manned laboratories (Spacelabs) developed by the European Space Agency (ESA) which will be orbiting at an altitude of 300 km.

60. Mainly, conventional photography will be used from Spacelab. Its contribution to the remote-sensing of natural resources will be derived from its capacity to carry into space a wide variety of sensors, particularly high-resolution photographic cameras (resolution of between 10 and 20 m, including stereocameras), radar scanning devices and various other sensors; for example, there are plans for it to carry a microwave radar, 10-channel infra-red radiometers, colour scanning devices for ocean observations, etc.

61. Because of the short flight duration and the high orbital inclination, these Spacelabs would not be able to overfly the same scene on the ground regularly and their use for routine remote-sensing would be limited.

62. The Stereosat satellite. This satellite is at present in a conceptual phase and no decision to build it has been taken. COMSAT Corporation has made a proposal for developing (with the participation of private industry) a satellite designed to meet demand for high-resolution, stereoscopic remote-sensing data which would supplement the data provided by the Landsat-D satellite. The space segment proposed by COMSAT for Stereosat would consist of three high-resolution "push broom" cameras with a 15 m IFOV.

(b) Soviet programmes

(i) Military satellites

63. The Soviet Union is believed to have developed and deployed a number of military satellites for earth observation and reconnaissance, for electronic reconnaissance, early-warning and surveillance of nuclear explosions. The main characteristics of these satellites are described below on the basis of the limited amount of information available.

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64. *Reconnaissance satellites*. Most satellites launched by the Soviet Union are designated Cosmos. The Cosmos satellites which have been identified with any degree of confidence as having a reconnaissance function are those which are recovered from orbit after a period of up to 14 days and which probably perform photographic reconnaissance missions from an altitude of between 100 km and 200 km. Until about the end of 1968, most of these satellites had orbital lifetimes of about eight days. A new generation of satellites, beginning from early 1968, had longer orbital lives of about 12 days. A further development - satellite manoeuvrability - marked the beginning of yet another type of satellite. This ability to change orbital characteristics increased the capability of the satellite to achieve precise coverage of specific areas. These satellites orbit the earth for 13 days and are similar to the United States close-look satellites.

65. In 1975, the Soviet Union launched a satellite at an orbital inclination of 67°. In fact such a satellite launched in February 1976 was in orbit for 20 days, and the second launched in April 1977 was in orbit for 30 days. The latter, probably was one of the first of the Soviet long-lived photographic reconnaissance satellites.

66. During times of international crisis, the number of satellites launched has been reported to increase rapidly compared to the number of routine launches, presumably for detailed coverage of the areas concerned.

67. *Electronic reconnaissance satellites*. It is not certain which of the large number of Soviet satellites in the Cosmos series are used for gathering electronic intelligence data. It is believed that the satellites launched from Plesetsk at an orbital inclination of about 71° and with orbital periods of 92 and 95 min. may be electronic reconnaissance satellites. Satellites launched in an orbit inclined at an angle of about 74° and with orbital period of about 95 min. may also fall into this group. It is possible that a number of Soviet photographic reconnaissance satellites may also be performing electronic reconnaissance.

68. *Ocean surveillance satellites*. One of the first of such satellites was launched in December 1967. The true nature of these satellites was not learned until 1974, when the United States Navy announced that the USSR had been developing an ocean surveillance satellite system.

69. The Soviet ocean surveillance satellites perform their missions in pairs. They are equipped with radar systems and, for good resolution, the satellites must fly in a low orbit (about 250 km). After a few weeks, the satellites eject part of their pay-loads which are manoeuvred into their parking orbit at greater altitudes of about 900 km.

70. *Early-warning satellites*. It is difficult to identify those Soviet satellites which are equivalent to the United States early-warning satellites, although the Soviet Union has probably developed similar systems. It has been suggested that the Molniya satellites, which spend a long time over North America while still being visible from Soviet ground stations, could be performing missile detection missions. Such satellites have highly elliptical orbits with 600 km perigee and 40,000 km apogee.

71. It appears that Cosmos-775, launched in October 1975 in geosynchronous orbit, could be the first Soviet early-warning satellite in such an orbit. The satellite was placed in position over the Atlantic Ocean where it could observe United States submarine-launched ballistic missiles.

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72. Nuclear explosion-monitoring satellites. It is difficult to identify which of the Cosmos satellites are nuclear-explosion detection satellites. For example, the Cosmos series includes no satellite with orbital characteristics analogous to those of the United States Vela satellites. There are reports that satellites in the Electron series would carry sensors similar to those used in the Vela series.

(ii) Civilian satellites

73. Many of the Soviet photographic reconnaissance satellites perform Earth resources missions as well. Moreover, much of the earth resources data collected from space and published in the USSR has been obtained from the manned space programme. Furthermore, the Soviet Union has continued with its manned space flights during which cameras for earth observation have been used. The second Salyut 6 crew, for example, took more than 20,000 multispectral photographs of different regions of the Earth. Of these, some 90 per cent were related to Earth resources management problems.

(c) The People's Republic of China's space programme

74. The People's Republic of China is the third country to develop recoverable capsule satellites. It may be assumed therefore that the satellites are engaged in photographic reconnaissance and that the films are later recovered - techniques which in principle provide high resolution data.

(d) French observation satellite programme

75. In February 1978, the French Government took the decision to initiate the SPOT programme (Système probatoire d'observation de la Terre - Pilot Earth Observation System) with the intention of launching the satellite using the Ariane launcher in 1984. The satellite is being developed nationally and in collaboration with Sweden and Belgium under bilateral agreements. It will be placed in orbit at an altitude of 822 km by the Ariane launcher.

76. The satellite is designed as a multimission platform and will be able to carry such sensing equipment as, for example, visible-light and infra-red instruments and synthetic aperture radar. It will be able to perform a wide variety of tasks - land observation, meteorological observation or oceanographic observation.

77. The first SPOT satellite will carry two identical instruments for obtaining high resolution visible-light and infra-red imagery. For multi-spectral scanning, operating in three spectral bands, SPOT will have a 20 m IFOV and for panchromatic scanning, a 10 m IFOV. The scanning field will be 120 km wide, and systematic coverage of the whole world will be effected in 26 days. The SPOT satellite is planned to obtain images of any part of the world in a period between a maximum of 5 days and an average of 2½ days. This is due to the possibility of adjusting the line of sight of the instruments and thereby selecting the field of view. The first SPOT satellite camera will observe the same area on the Earth's surface from different angles in order to obtain a stereoscopic view. Much can be learnt from stereoscopic imagery about geological structures and surface relief.

78. The SPOT platform has been designed to carry a wide variety of payloads and in future launchings it will probably be used for several purposes. SPOT data is expected to be in a form compatible with the Landsat system.

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(e) Indian space programme

79. India built its first experimental Earth observation satellite (SEO-1) which was placed in a circular orbit at a height of 525 km by a Soviet launcher on 7 June 1979. The satellite is equipped with a visible-light and near infra-red television camera with a 1 km IFOV, and also with a microwave radiometer. The television camera and the radiometer are transmitting meteorological and oceanographic data.

80. A second Indian remote sensing satellite (IRS-1), is to be launched in 1983. Its instruments for obtaining images will operate on a number of spectral bands and will have less than 100 m IFOV. An Indian-built experimental satellite was launched in July 1980 using an indigenously built launcher.

(f) Japanese space programme

81. A satellite designed for marine observation (MOS-1) is being developed in Japan, and its launching is scheduled for 1984. It will be fitted, *inter alia*, with a four-band visible-light and infra-red sensor with a 50 m IFOV. The width of the scanning band will be 100 km. This first satellite, which will also be used for developing observation techniques, will be followed by other satellites designed for marine observation and later, from 1987 onwards, by land observation satellites.

(g) European Space Agency (ESA)

82. ESA is at present studying two remote sensing satellite projects, as follows:

LASS: Land Application Satellite Systems for Earth observation, and
COMSS: Coastal Ocean Monitoring Satellite System for marine observation.

Among the options under study are synthetic aperture radar with a 24 m IFOV and scanning radiometers operating on a number of visible-light bands. COMSS could also have a scanning sensor. If the present studies lead to a decision by ESA to launch remote sensing radiometers, the first one could be placed in orbit at an altitude of 600 550 km in the mid-1980s

83. For the first spacelab flight, ESA has developed a metric camera and a microwave sensor for which it has received a large number of proposals for experiments from scientists in several countries. Canada has shown interest in these studies and has recently concluded an agreement with ESA.

(B) Weather satellites relevant to an ISMA

(a) Military Weather Satellites

84. In the United States there is a recent trend to incorporate sensors for both military and civilian missions on the same satellite. These and earlier satellites carry a number of different sensors to measure various physical properties of the atmosphere.

85. The current United States satellites orbit in sun-synchronous polar orbits providing the armed forces with real-time global and local visible and infra-red images with resolution of 0.5 km IFOV. Satellites in geosynchronous orbit carry sensors with resolution of 0.9 km IFOV.

86. In the Soviet Union, the routine use of satellites for monitoring weather began in 1969. Because of the short active life of the Soviet weather satellites a relatively large number of these are launched per year. Moreover, these satellites orbit at altitudes of about 850 km with orbital inclinations of 81°.

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(b) Civilian weather satellites

87. These systems comprised satellites of two types:

(a) near-polar orbiting (with orbital altitude ranging from 800 to 1,000 km in sun-synchronous orbits); and

(b) geostationary (placed at an altitude 36,000 km over the equator).

These satellites provide data to users through:

(i) direct transmissions to ground stations,

(ii) on-board storage of data with subsequent transmission to a ground station on command; and

(iii) relay of data via satellites (such as in-situ observations and WEFAX).

Polar orbiting satellite systems have been operational since 1963, while geostationary satellites became operational in 1975.

88. Following the successful launch of NOAA-6 (June 1979), the United States has fully accomplished the transition to the third generation of polar-orbiting satellite systems. TIROS-N, the first satellite in this system (launched in 1978), performs its operational missions together with NOAA-6. Data from the TIROS Operational Vertical Sounder (TOVS) and the Advanced High-Resolution Radiometer (AVHRR) are available to users with satellite receiving equipment through Direct Sounding Transmission (DST), Automatic Picture Transmission (APT), and High-Resolution Picture Transmission (HRPT) services. In addition to the ARGOS data-collection and location mission, TOVS sounding data are being distributed over the Global Telecommunication System (GTS) in the WMO SATEM and SARAD code forms. The METEOR-2 meteorological satellite (two to three satellites in orbit) forms the basis of the USSR's polar-orbiting operational satellite system. These satellites provide images (both visual (VIS) and infra-red (IR)) of cloud, as well as of snow and ice cover. They also provide cloud-top temperatures and heights, temperatures and values of outgoing long-wave radiation and reflected solar radiation. The data from these satellites are being processed and distributed on the GTS in pictorial and other forms. Experimental METEOR satellites (third generation) are capable of providing APT service for transmission of VIS pictures, obtained by scanning telephotometers equipped with multi-spectral and microwave sensors. The United States Geostationary Operational Environment Satellites (GOES-3), launched by the United States in June 1978, GOES-2, SMS-1 and SMS-2, launched earlier, are currently in full or partial operation providing WEFAX, VIS and IR image transmissions and information relay from data-collection platforms (DCPs). During 1979 GOES-1 was removed to a position over the Indian Ocean (approximately 60°E) and was operated jointly by the United States and ESA to provide imagery for the First GARP Global Experiment (FGGE). The Japanese Geostationary Meteorological Satellite (GMS), launched in July 1977, provides VIS and IR imagery, as well as data-collection and dissemination (WEFAX, DCPs) services. GMS-2, the successor to GMS, which will have basically the same functions as GMS, is now under development; its launch target is set for 1981. The ESA's geostationary satellite METEOSAT, launched in November 1977, was in operation until the end of 1979, when image data acquisition/transmission was interrupted due to a failure in the onboard overvoltage protection unit. However, DCP capability is still operational.

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89. The above geostationary satellites (GOES, GMS and METEOSAT) also provided Aircraft to Satellite Data Relay (ASDAR) services, contributing to the WWW/GOS and FGGE. The data collection and platform location capabilities of polar orbiting satellites were particularly useful for obtaining information from mobile platforms such as drifting buoys. Both polar-orbiting and geostationary satellites continue to be complementary in providing meteorological information for WWW and other WMO Programmes, for data collection and relay of in-situ observations from properly instrumented fixed and mobile platforms, and provide a capability for distribution by direct transmission to ground stations. Data from satellites would give information on cloud coverage for mission planning in an ISMA. This would be of relevance when an ISMA would operate its own satellites.

(C) Remote sensing satellite data receiving and processing facilities

(a) General

90. As described in paragraph 10 above, data collected by earth observation satellites are transmitted to the Earth either in the form of photographic imagery or electronic signals. Remote sensing data are received by ground stations either in real time mode or in time delay mode. In the former case, data would be received when the satellite is within radio-visibility of the receiving station or if data are relayed by telecommunications satellites. In the latter case, data is stored on-board the satellite and transmitted on command when it is within radio-visibility of a receiving station.

91. The command to transmit data may be prestored in the on-board computer, or it may be relayed to the satellite from the ground. On the ground, the data are processed and either transferred to computer-compatible tape (CCT) or converted into images. A ground station thus consists of a receiving antenna, and facilities for data reception, processing, storage, as well as imagery, reproduction and communication.

92. In the field of image processing, techniques have been developed to digitally superimpose data from the same scene acquired by different sensors. For example, Landsat optical imagery can be combined with radar imagery. The result is an improvement in terms of quality.

(b) Remote sensing data receiving and processing centres

93. The coverage areas for both existing and planned stations in the world mainly devoted to Landsat missions are shown in Figure 1, Annex IV. Although some countries have used data from the remote sensing system operated by the USSR, no information concerning existing and planned stations for coverage by this system was available to the Group.

(i) United States of America

94. Data reception and preprocessing systems in the United States are based mainly on NASA facilities but other government agencies act as distributors. The most important of these, the EROS Data Center of the Department of the Interior, provides a general service to industry, other governmental bodies, universities, foreign agencies and the general public. The over-all United States system consists of:

1. Three NASA reception stations located in Fairbanks, Alaska; Goldstone, California; and Greenbelt, Maryland;

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2. NASA Data Processing Facility (NDPF) in Greenbelt;

3. Distribution centres, particularly the EROS Data Center in Sioux Falls, South Dakota.

95. In addition to the above there is the Landsat operations control centre in Greenbelt - but since this is a satellite support function which is as much a prerequisite as the satellite itself, it is not discussed further in this report. Data received at the remote stations are recorded on magnetic tapes and sent to the NDPF whence they undergo processing in up to four data processing subsystems producing either film, high density digital tapes or CCTs is undertaken. These products are then made available to NASA's principal investigators and the data distribution centres. The largest distributor is the EROS Data Center which supplies images and CCTs to users on request and payment. EROS presently has the capability to reproduce black and white and colour images in a large variety of formats and to reproduce CCTs.

96. In addition to the reproduction facility, the EROS Center offers various types of assistance to users, which include:

(a) microfilm images, data bank terminals and image catalogues located in various regions and at the EROS Center itself to assist in ordering data;

(b) training courses in remote sensing and data application;

(c) expert assistance in application techniques using presently available data processing and display equipment;

(d) a library of remote sensing information is maintained.

(ii) Africa

97. In March 1977 the Conference of Ministers of the United Nations Economic Commission for Africa (ECA) decided to establish three stations in Africa for the reception, processing, archiving and distribution of satellite data on natural resources. These stations, established in such a way as to provide the best possible coverage of the African continent will be in Nairobi (Kenya), Kinshasa (Zaire) and Ouagadougou (Upper Volta). The installation of the Ouagadougou receiving station, is scheduled for completion in 1984. It would be capable of receiving data from Landsat, the French SPOT satellite and meteorological satellites (METEOSAT, MOS-I).

98. Centres for training, consultancy and user-assistance have been established in Cairo (Egypt), Ile-Ife (Nigeria), Nairobi, Kinshasa and Ouagadougou.

99. The activities of those various centres are co-ordinated by the African Remote-Sensing Council, with headquarters in Bamako (Mali).

100. The operations of the African and other regional Remote Sensing Centers may be of potential relevance to an ISMA in its first phase, since such regional data processing, analysis and training centres are dependent in their operation on outside sources.

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(iii) Argentina

101. The Mar Chiquita satellite data receiving station has been in operation since April 1980 and is programmed to receive data from Landsat satellites and from GOES, TIROS-N, Nimbus and SPOT satellites. The information received at Mar Chiquita is analysed at the Buenos Aires satellite data processing centre. This has the capacity not only to process and reproduce high-density tapes recorded at Mar Chiquita, but also to produce and distribute final products, with geometric and radiometric corrections. In mid-1981, a direct read-out GOES receiving station will be in operation in the western part of the country.

(iv) Australia

102. The receiving station in Alice Springs began reception of Landsat data in November 1979. The data processing system in Canberra became fully operational in November 1980 and supplies a range of photographic products and computer compatible tapes to the user community. The Australian Bureau of Meteorology operates several facilities for the reception and processing of data from meteorological satellites.

(v) Brazil

103. The Brazilian telemetry and recording station located in Cuiabana working with Landsat data was established in 1973. The magnetic tapes are transported to a central data processing facility where CCTs and film products are produced for analysis and distribution.

(vi) Canada

104. The ground stations (Prince Albert established in 1972 and Shoe Cove established in 1977) receive data from Landsat and NOAA satellites. The data are then transmitted to an image processing centre where data are converted into digital data and black and white/coloured imagery. Four days after the images are recorded by a satellite, a private firm distributes daily the data to Canadian users. Seasat data was also received for a short period.

(vii) People's Republic of China

105. It is planned to set up a ground network including stations and data processing centres, to be managed by the Academy of Sciences. With this in view an agreement has been concluded with NASA for a Landsat-D receiving station.

(viii) Egypt

106. The Egyptian Remote Sensing Centre at Cairo established in 1971 has advanced Satellite and Aircraft digital data and image processing facility. Egypt also has advanced colour photographic development and control, and target spectral measurements laboratories. The building of a receiving station to handle data from both the French SPOT and the United States Landsat satellites is presently being discussed between Egypt and the French and American Governments. The centre is expected to serve as a regional centre for Africa as well as for the Group of Arab States.

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### (ix) France

107. The Lannion station is equipped for receiving and preprocessing Nimbus-G satellite data. This station is included in the French meteorological space centre. With regard to data analysis, the main centre is the Groupement pour le Développement de la Télédétection Aerospatiale (GDTA). This group co-ordinates efforts in developing and promoting remote sensing techniques. The data analysed by GDTA are at the disposal of users. A receiving station for data from the future SPOT satellite and compatible with the United States Landsat system is now being set up at Toulouse.

### (x) India

108. The receiving and processing station in Hyderabad began taking test data from Landsat in August 1979. The station is operational and is to function as a regional centre for data dissemination.

### (xi) Iran

109. Iran also has a Landsat data receiving station in Teheran which is completed but it is not operating as of December 1980.

### (xii) Italy

110. The Italian receiving station completed in 1975 is located in Fucino. It has been specifically designed for receiving Landsat data. This station has both receiving and preprocessing facilities. MSS data received from the Landsat are recorded directly on high density digital tapes (HDDT). Play back of the HDDT then provides a data input to a preprocessing system based on minicomputers which can produce a variety of images and CCTs.

### (xiii) Japan

111. The National Space Development Agency (NASDA) of Japan has completed in 1979 the construction of the ground stations for receiving remote sensing data. The stations are now operating. Several institutions, including the Remote Sensing Technology Centre of Japan (RESTEC) operate their own data analysis system and provide analysis services.

### (xiv) South Africa

112. A ground station is planned in South Africa which has concluded an agreement with NASA for a Landsat receiving station.

### (xv) Sweden

113. The Swedish Landsat receiving station at Kiruna has been operational since 1979. The station delivers CCTs, quick look photographic products and preprocessed data through Earthnet.

### (xvi) Thailand

114. The National Research Council of Thailand is planning construction of a Landsat receiving station in the near future. Efforts are underway to establish an Asian remote sensing training centre utilizing data from the Thai ground station to train resource managers in image and digital Landsat data analysis techniques.

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(xvii) United Kingdom

115. The Oakhanger station is equipped for receiving and processing Seasat data. The main facility is a digital system for SAR data processing. Facilities also exist for processing and interpretation of data obtained from aircraft and other types of satellites.

(xviii) European Earthnet Programme

116. Earthnet is the ESA network to receive, process, archive and distribute earth resources and environmental data from remote sensing satellites. France, Italy, Spain, Sweden and the United Kingdom are actively participating in the programme. Figures 2 and 3 of Annex IV indicate stations situated in various European countries and their coverage. The Fucino station (Italy) and Kiruna (Sweden) handle missions concerning the Landsat satellite. The Oakhanger (United Kingdom) and Maspalomas (Canary Islands) stations operate with Seasat missions. The Lannion station and part of the Maspalomas station are used for HCMM and Nimbus-G missions.

117. As regards the distribution of data, member States have been invited to appoint national centres which could interact with Earthnet. The other task of such national centres would be to promote the use of such data, and to arrange an exchange of information between users.

118. The central distribution facility in Frascati Italy (ESRIN) is charged with the distribution of Landsat imagery to users in countries where no national centres exist. It is also possible to interrogate the Frascati archives in real time through computers.

(xix) Other facilities

119. Apart from centres mentioned above, there exist in other countries facilities for remote sensing facilities for processing and analysing remote sensing data and/or for training, consultancy and user-assistance.

(D) Launchers

120. The next decade is expected to produce major changes in space transport systems arising from developments in fields like materials, electronics and launcher technology. The United States space transport system in the 1980s would be based on the Space Shuttle which is scheduled to become operational in 1983. The shuttle comprises four components:

(a) An orbiting vehicle (Orbiter) to place a spacecraft in a low orbit (300-400 km);

(b) A large non-recoverable aluminium tank to carry fuel for the Orbiter;

(c) Two recoverable solid-fuel rocket engines mounted on either side of the main tank; and

(d) Recoverable orbit transfer stages, carried in the load compartment, would transfer the load from a low terrestrial orbit to a higher orbit (for example, geostationary orbit), or into an interplanetary trajectory. One type of stage, the

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Inertial Upper Stage (IUS), is capable of carrying loads of 2,400-3,000 kg into geosynchronous orbit. The second type is the Spinning Solid Upper Stage (SSUS). A SSUS-D can place about 1,100 kg in a geosynchronous orbit while SSUS-A can place about 2,000 kg in a geosynchronous orbit.

121. The Soviet Salyut 6-Soyuz-Progress assembly makes the Salyut orbiting station, where Soyuz is the manned spacecraft and the Progress is the unmanned cargo vehicle. The Soyuz and Progress vehicles are launched by the Soyuz three-stage rocket which is capable of placing a load of over 7,000 kg in low orbit. The Salyut 6 sation weighs 18,900 kg.

122. The ESA has developed the three-stage, non-recoverable launcher Ariane. It can place 4,500 kg in low orbit, more than 1,700 kg in transfer orbit for geosynchronous missions, and more than 900 kg in a geostationary orbit. By 1983 a development programme should enable Ariane to place more than 2,300 kg in a geosynchronous transfer orbit, a figure which is equivalent to placing a load of 1,250 kg in a geostationary orbit.

123. The People's Republic of China has also developed its own launchers for orbiting heavy satellites.

124. Other countries including India and Japan have also developed their own satellite launching capabilities.

### (E) Trends in remote sensing

#### (a) General

125. To meet civilian user requirements of remotely sensed data, preliminary studies have already been made for systems to be developed over periods extending up to the year 2000. According to these studies, remote sensing technology is likely to develop steadily in view of the growing demand for improving the performance of sensors on civilian satellites.

126. In this context it can be mentioned that as far as Landsat is concerned the United States has decided to begin the transition from "experimental" to "operational" systems. The NOAA has been given responsibility for civilian activities concerning the operational remote sensing of earth resources. Initially the NOAA remote sensing system would use technology from the current Landsat programme.

127. Existing and planned civilian remote sensing satellites do not have a capability to ensure a level of performance necessary for detailed observation of crisis areas or for the identification of armaments subject to disarmament agreements. In the future, however, considerable progress may be expected which could bring the performance of civilian satellites close to military ones used for area surveillance. Such a development would be of great importance for the establishment of an ISMA since it would make available necessary data from sources other than military surveillance satellites. For this reason, the continued availability of data from civilian satellites will be of significance for future developments in the field of verification of disarmament agreements and crisis monitoring by satellites.

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(b) Platforms

128. It can be expected that large space structures will be developed and it would be possible to install on board future remote-sensing satellites equipment such as on-board processors and larger (optical or other) instruments with a better performance than those in use at present. In general, it is expected that these large structures will permit the introduction of multipurpose systems designed to meet the needs of various types of users at the same time.

129. The use of these large space structures, which could begin some time between 1985 and the year 2000, may be launched by transport vehicles of the "Shuttle" type. These manned recoverable vehicles are expected to lower the cost of launching satellites and lead to cheaper methods of satellite construction. Repair or replacement of satellites would also be made possible. Moreover, it would be possible to use the structures themselves as observation platforms, as shown by the many remote-sensing experiments carried out on the Salyut and Skylab stations or planned for the Spacelab.

(c) Sensors

130. Considerable progress is expected in the field of optical-electronic detectors, particularly in infra-red sensors, microwave sensors and SAR. These developments, to the extent they lead to general availability of systems and components, would be of importance to ISMA from the point of view of night and all-weather observation.

(d) Data transmission and reception

131. Improvements in sensors would lead to high volume digital transmission and reception. The use of higher frequency bands may be necessary. On-board data processing compression techniques may also become necessary and may to some extent facilitate this development. Moreover, the use of relay satellites for data transmission may make it possible to eventually reduce the number of ground receiving stations which have geographical limitations.

(e) Data processing and interpretation

132. Significant development in image processing techniques designed around array processors are expected in the early 1980s. The combination by computer of data received from different sensors would also be possible. These would have an impact on automated pattern recognition and scene analysis reducing human intervention and delay.

## II. TECHNICAL MISSION AND DATA REQUIREMENTS OF AN ISMA

(a) General

133. This section examines the nature of prohibitions or control resulting from existing and future multilateral or bilateral treaties, and the technical monitoring missions that the Agency could perform using its own satellite system, together with the data requirements for monitoring. The texts of the verification provisions of existing arms control or disarmament agreements are reproduced in Annex V.

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134. The technical missions which an ISMA would be required to perform could be of two main types:

(i) monitoring of compliance with disarmament/arms control agreements; and

(ii) monitoring of crisis situations.

135. The requirements concerning resolutions, area coverage, frequency of coverage, response time and auxiliary data would be different for these two types of mission. Further, limitations arising from factors like suitability of space surveillance for specific disarmament agreements would influence the effectiveness of satellite verification. In this section, salient features and estimates of data requirements of these missions are presented. Section A deals with disarmament/arms control agreements strictly from the technical point of view without prejudice to the legal implications which are dealt with in Chapter Two below. Section B considers technical requirements for monitoring compliance with international arms regulations and disarmament agreements to be concluded in the future, Section C considers monitoring of bilateral and other accords, and Section D considers crisis monitoring.

## A. Monitoring compliance with existing international arms regulations and disarmament agreements

136. For more detailed descriptions of each of the following agreements and their verification provisions, see Chapter Two.

### (a) Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other gases, and of Bacteriological Methods of Warfare (Geneva Protocol, 1925)

137. The Protocol prohibits the use of chemical and biological (CB) substances in warfare. An ISMA could report on "characteristics of specialization" associated with, for example, special personnel and protection measures observable from space. Such reports could be important as supportive information about violation of Treaty obligations.

138. It should be noted that it may be difficult to identify CB agents and activities related to the use of these agents from sensors on satellites. Research in satellite monitoring of environmental pollution using advanced spectroscopic equipment may, however, contribute to the solution of these problems.

139. An estimate of technical requirements in this connection would be:

(i) resolution: about 0.5 m, supplemented by quick-look area surveillance imagery of resolution in the range 3-5 m; optical and IR sensors;

(ii) area and frequency of coverage: arbitrary; depending on frequency of conflicts; linked to crisis monitoring mission of an ISMA;

(iii) response time of system; preferably reporting once every 24 hours;

(iv) auxiliary data: timely information for image acquisition; data bank containing high resolution imagery; maps; weather satellite data;

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(v) monitoring limitations: only indirect indicators of CB warfare activities are identifiable from space; technical resources affecting coverage frequency and image analysis; verification of allegations of violation would need early or almost immediate on-site visits of specialists; no verification provision in the Protocol.

(b) Antarctic Treaty (1959)

140. The Antarctic Treaty prohibits military measures like establishment of bases, military manoeuvres or testing of any type of weapon, as well as nuclear explosions and disposal of radio-active waste, in Antarctica. Area surveillance and close-look satellites would be able to detect and describe military measures prohibited by the Treaty. For detection of nuclear explosions, a separate satellite with optical, IR and nuclear radiation detectors would be required.

141. An estimate of technical requirements in this connection would be:

(i) resolution: area surveillance at 3-5 m; occasional close-look at about 0.5 m; sensors; optical, radar (essential since the area is either in darkness or under cloud cover for most of the year), IR, nuclear radiation;

(ii) area coverage and frequency: area surveillance possibly over about 1,000 sq. km, frequency arbitrary, possibly at half-yearly intervals; frequency of close-look coverage uncertain;

(iii) Response time; possibly half-yearly or as soon as possible after observation;

(iv) Auxiliary data: information from records relating to implementation of Treaty available with Parties; data bank; maps; weather satellite data; timely information for image acquisition; linked information on nuclear programmes of Parties;

(v) monitoring limitations: radio-active waste disposal not verifiable; technical resources affecting coverage frequency and image analysis; separate nuclear explosion detection satellite needed which, however, would not pin-point test area; close-look imagery would provide only supportive information on military measures.

(c) Partial Test Ban Treaty (1963)

142. Parties to the Treaty undertake to prohibit, prevent and refrain from any nuclear test in the atmosphere, outer space, or under water. In addition to inter alia seismic methods, verification of compliance with the Treaty can be monitored by satellites in the following ways:

(i) photography of preparatory activities on ground for nuclear tests;

(ii) measurement of nuclear and other electromagnetic radiation from the test.

143. The first way would lead to information of significance to preventive measures while the second would only serve to confirm a fait accompli for which there are less expensive methods in existence. It would be possible to detect and report Treaty compliance through routine area surveillance and occasional close-look coverage for test preparatory activities at known or suspected nuclear test sites. For the detection of nuclear tests, optical, IR and nuclear radiation sensors like those used in the United States Vela satellite would be necessary. Such satellites orbiting in pairs have nearly circular orbits at about 111,000 km with an inclination of about 32°.

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Alternatively it is possible to use satellites in geosynchronous orbit. Such nuclear test detection satellites would not, however, be able to pin-point the test area. They could corroborate information from seismic/microbarographic networks.

144. A brief description of technical requirements for an ISMA with the task of detecting preparatory activities would be:

(i) resolution: area surveillance at 3-5 m, supplemented by close-look at about 0.5 m of suspected ground sites; sensors; optical, IR, nuclear radiation;

(ii) area and frequency of coverage: with over 110 Parties, selective global area coverage possibly twice a year; close-look area uncertain, frequency occasional;

(iii) response time of system: days in the case of reports based on close-look imagery before or after a violation; possible half-yearly reporting based on area surveillance imagery;

(iv) auxiliary data: information on nuclear programmes of Parties; advance information for close-look image acquisition; data bank; maps; weather satellite data; inputs from IAEA regarding weapons-grade fissile material production and disposition resulting from the verification of NPT and the Treaty of Tlatelolco; inputs from seismic/microbarographic networks; information from the verification of the Antarctic Treaty;

(v) monitoring limitations: Article 1(b) regarding fall-out outside territorial limits not verifiable from space; imagery would yield only supportive information; Vela type sensors would conclusively indicate a test, but area pin-pointing poor; technical resources affecting average frequency and image analysis; separate surveillance and nuclear explosion detection satellites needed.

### (d) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (1967)

145. The Treaty prohibits the placing in orbit around the Earth of objects carrying nuclear weapons and other weapons of mass destruction, installing them on celestial bodies or the stationing of them in outer space in any manner (Article IV). The establishment of military bases, installations, the testing of weapons and military manoeuvres on the Moon and other celestial bodies are also forbidden.

146. In practice, the precise identification of the payloads of orbiting satellites and, particularly, the detection of the presence on board satellites of nuclear weapons or other weapons of mass destruction necessitates close-look inspection of suspect satellites by means, for example, of a fly-by with a manoeuvrable spacecraft. While such systems are, technically, already perfectly feasible, their nature and cost are such as to exclude them particularly when systems considered are those which observe the Earth's surface from space. Space systems designed essentially for Earth observation do not lend themselves easily to the monitoring of compliance with the other provisions of the Treaty concerning military activities on the Moon and other celestial bodies.

### (e) Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco) with additional Protocols I and II (1967)

147. The Treaty establishes a nuclear free zone in Latin America. The "Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL)" established under this Charter could utilize the services of an ISMA as a space adjunct to the Treaty verification.

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148. The contributions of an ISMA in this connection could be photographic coverage of preparatory activity at possible areas on ground for nuclear tests:

(i) area surveillance on a half-yearly basis of the zone of application of the Treaty (defined in Article 4) on a request from OPANAL;

(ii) close-look imagery in relation to "Special Inspections" to be carried out by the Council of OPANAL and IAEA under Article 16, on a request from OPANAL.

149. Additionally, a satellite equipped with optical, IR and nuclear radiation detectors designed to detect nuclear explosions would be required to provide confirmatory information. It would, however, not pin-point the test area. Under Article I, Parties undertake to monitor the testing, use, manufacture, production, acquisition, receipt, storage, deployment, etc. of nuclear weapons. Space surveillance would yield supportive information on preparations for a nuclear test, post test effects as well as possible deployment on the ground. Other parts of the Article (for example, production and acquisition) would be difficult to verify by an ISMA. The zone of application includes oceanic areas and compliance with Protocol II by nuclear-weapon States would need satellites with an ocean monitoring capability.

150. The technical requirements of an ISMA for verification of compliance with this treaty would be like those mentioned in paragraph 139 in connection with the Partial Test Ban Treaty discussed above.

(f) Treaty on the Non-Proliferation of Nuclear Weapons (NPT) (1968)

151. The Treaty prohibits the transfer by nuclear-weapon States to any recipient of nuclear devices or their control; it also prohibits assistance, encouragement or inducement to a non-nuclear-weapon State to manufacture or acquire such devices. It also prohibits non-nuclear-weapon States from receiving such devices or control over them and from manufacturing/acquiring such devices. The contribution of an ISMA in connection with NPT could be in the nature of surveillance from space of construction of nuclear facilities, nuclear test preparation or of testing as a supportive input to operation of the IAEA safeguards system. Space surveillance would not be effective in verifying manufacturing activity or other means of acquiring such devices. Nor would nuclear material audit be feasible.

152. As in the case of the Treaty of Tlatelolco and the Partial Test Ban Treaty, an ISMA could provide:

(i) area surveillance of target areas in the countries parties to Treaty;

(ii) close-look imagery in connection with diversion of special nuclear material leading to a possible nuclear test by a Party to the Treaty.

153. Violation of the Treaty by non-nuclear-weapon States parties to the Treaty would be detectable by IAEA through its safeguards apparatus operating on safeguarded facilities. The contribution of an ISMA could only be in the nature of photographic information indicative of preparatory activity for a nuclear test or through measurement of nuclear, visible and thermal radiation after the test.

154. The technical requirements for an ISMA in this connection would be similar to those mentioned in paragraph 139 in connection with the Partial Test Ban Treaty.

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(g) Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Sub-Soil Thereof (Sea-Bed Treaty) (1971)

155. The Treaty prohibits emplacement on the sea-bed, ocean floor and in the sub-soil beyond the 12-mile outer limit of territorial waters, any nuclear weapons or other weapons of mass destruction as well as structures and launching facilities designed for storing, testing or using such weapons. Available information on sensors would indicate that surveillance from space is inadequate to detect and describe objects or facilities emplaced on the sea bed and ocean floor covered by this Treaty. This Treaty would therefore appear to be unverifiable by an ISMA at present.

(h) Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction (Biological Convention) (1972)

156. The Convention prohibits the development, production, and stockpiling of biological agents or toxins and for the destruction of their equipment or delivery systems designed for such agents or toxins for hostile purposes.

157. Surveillance from space could enable identification of training experiences of an Army or munitions testing related to biological warfare. The identification of such agents would, however, be difficult. Compliance with other provisions in the Convention relating to production, stockpiling, destruction, diversion to peaceful uses, etc. would not be easily detectable from space with the exception of the destruction of stockpiles, subject to advance notification and verification to ensure that destruction had actually taken place.

158. Technical requirements of an ISMA in this connection would be:

(i) resolution: close-look at about 0.5 m of suspected training/testing areas;

(ii) area and frequency of coverage: area uncertain, linked to crisis monitoring;

(iii) response time: days from imagery request to reporting;

(iv) auxiliary data: weather satellite data; data bank, maps, training sets for image analysis; advance information for image acquisition;

(v) monitoring limitations: only manoeuvres, testing and use in conflict detectable; other Articles not verifiable

(i) Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques (ENMOD Convention) (1977)

159. The Convention prohibits the employment of environmental modification techniques for military or any other hostile purpose.

160. Available information would indicate that surveillance from space may identify gross environmental changes on the surface of the Earth and in the atmosphere but the causes of such changes, whether deliberate or not, cannot be identified with any confidence. It would appear that the Convention may not, therefore, be verifiable through surveillance from space but there could be some supportive contribution from weather satellite data.

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## B. Monitoring compliance with future international arms regulations and disarmament agreements

161. Compliance with a future convention prohibiting chemical weapons could to a certain extent be verified by using monitoring satellites. Data required and monitoring limitations would be similar to the Geneva Protocol and Biological Convention (paras. 134 and 153).

162. As far as the Comprehensive Nuclear Test Ban Treaty is concerned, the verification potential and data requirements would be the same as for the Partial Test Ban Treaty (para. 139).

163. Proposals have been made for treaties dealing with the denuclearization of various regions of the globe. If such nuclear-weapon-free zones agreements were to materialise along the patterns of the Treaty of Tlatelolco then ISMA's contribution to verification would be as discussed in section A (c) above.

164. In October 1980, negotiations under the auspices of the United Nations resulted in the drafting of a Convention prohibiting or restricting the use of certain conventional weapons deemed to be excessively injurious or to have indiscriminate effects; weapons producing fragments which cannot be detected in the human body by X-rays, land mines, booby traps and other devices, and incendiary weapons. This Convention will be open for signature by States from 10 April 1981. A Protocol prohibits or restricts the use against civilians of incendiary weapons; flame throwers, fougasses, shells, rockets, grenades, mines or napalm bombs, and other containers of incendiary substances. Consequently, there are now in existence a number of definitions of the weapons and weapon systems to which the Convention relates. However, it remains to be determined under what conditions, technically speaking, an ISMA could verify the implementation of these texts. At this stage, it would appear that the possibilities of observing compliance with certain parts of conventions may be similar to those that would be necessary for monitoring the implementation of the Geneva Protocol or of a convention on chemical weapons.

## C. Monitoring bilateral and other accords

165. ISMA could also play an important role in the monitoring and verifications of bilateral disengagement agreements involving accords on limitations of forces and armaments in designated zones and in other areas of potential conflict.

## D. Monitoring of international crises

### (a) General

166. Apart from verification of compliance with disarmament/arms control agreements discussed above, as the primary mission of an ISMA, the Agency could also contribute effectively to observation from space of military aspects related to the development and progress of conflicts. It is conceivable that in this function an ISMA could provide:

(i) early-warning of attacks through observation of build-up of military and para-military forces;

(ii) evidence of border violations;

(iii) cease-fire monitoring;

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(iv) assistance to United Nations observers and peace-keeping missions;

(v) strengthening of international confidence-building measures and observation of the use of, or threat to use, force.

167. While the verification of disarmament agreements would, in general, depend on area surveillance imagery supplemented by occasional close-look imagery, the crisis monitoring function would have to rely extensively on close-look imagery with area surveillance providing a secondary, but important, source of information.

168. To fulfil the task of crisis monitoring an ISMA would need satellites with sensors having very high resolution capacity - of the order of 1 m or less. Sensors with this capacity would in general be using photographic techniques. The photographs taken by these sensors could either be scanned on board the satellite and the data transmitted to Earth at a high bit rate telemetry or the exposed films could be recovered over land or sea through use of capsule recovering techniques. In addition, the satellite should be capable of being manoeuvred in order to cover areas of conflict appropriately in time and location. The effectiveness of crisis monitoring would also depend on the number and location of ground stations and the data transmission system linking them to the data processing centre. Depending on operating procedures, the imagery data telemetred down may have to be encrypted. Choice of sensors, resolution and orbital elements would be governed by operational requirements like area coverage and frequency, cloud cover and availability of technology. The frequency of coverage of an area would be influenced by the type of reporting expected from and the technical resources available to an IMSA. For instance, in the pre-crisis period, coverage once in every five to seven days with a suitable sensor package may be adequate to provide information for reporting on military preparations which would be useful for an ISMA's early-warning function. A higher frequency, possibly twice or three times a day, during the crisis would serve to update the pre-crisis information and be capable of providing evidence for appropriate international measures. A considerable burden would be placed on data processing and analysis within an ISMA in order that reporting would be accurate, timely and incontrovertible. This would imply that, apart from photo-interpretation skills of the highest order, an ISMA would need timely correlative information on the structure, strength, equipment, training exercises and military installations of the armed forces of various States. In the confidence-building function, an ISMA would be able to use its satellites to report on situations involving the use of, or threat to use, force in international affairs arising from many factors, including large asymmetry in the structure and strategy of armed forces of States.

(b) Resolution and sensors

169. An estimate of the resolution required of satellite sensors by an ISMA for detection, recognition and identification of military objects, based on authorized information, is given in table I. The figure would apply to average illumination conditions at medium latitude and average contrast. It would appear from this table that a resolution of about 3-5 m would be sufficient for detection of all the objects mentioned above, while a resolution of about 0.5 m would be sufficient to identify and describe most of them.

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### Table I

### Ground Resolution required for treaty verification and crisis monitoring (in metres)

| Object | Detection | Recognition | Identification | Description |
|---|---|---|---|---|
| Bridges | 6 | 4.5 | 1.5 | 0.90 |
| Radar | 3 | 0.9 | 0.3 | 0.15 |
| Radiocommunications | 3 | 1.5 | 0.3 | 0.15 |
| Material depots | 1.5 | 0.6 | 0.3 | 0.25 |
| Troop units or bivouacs | 6 | 2.1 | 1.2 | 0.30 |
| Air base equipment | 6 | 4.5 | 3 | 0.30 |
| Artillery and rockets | 0.9 | 0.6 | 0.15 | 0.05 |
| Aircraft | 4.5 | 1.5 | 0.9 | 0.15 |
| Headquarters | 3 | 1.5 | 0.9 | 0.15 |
| Ground-to-ground missile and anti-aircraft sites | 3 | 1.5 | 0.6 | 0.30 |
| Medium-sized surface vessels | 7.5 | 4.5 | 0.6 | 0.30 |
| Vehicles | 1.5 | 0.6 | 0.3 | 0.05 |
| Land mine fields | 9 | 6 | 0.9 | 0.025 |
| Ports | 30 | 15 | 6 | 3 |
| Coasts and landing beaches | 30 | 4.5 | 3 | 1.5 |
| Marshalling yards and railways shops | 30 | 15 | 6 | 1.5 |
| Roads | 9 | 6 | 1.8 | 0.6 |
| Urban areas | 60 | 30 | 3 | 3 |
| Military airfields | - | 90 | 4.5 | 1.5 |
| Submarines on the surface | 30 | 6 | 1.5 | 0.9 |

### (c) Area coverage and frequency response time

170. Area to be covered in the pre-crisis period would be difficult to estimate since it could vary with the number and types of crises, and the geographic element between involved parties. For purposes of planning, an open assumption of the

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area would be of the order of $10^5 - 10^6$ sq. km during a year. The frequency of coverage of a part (not estimated) of this total area in the pre-crisis period could be once in five to seven days. This would be adequate in enabling an ISMA to provide early-warning reports of attacks in areas of tension. During a period of crisis, a higher frequency of coverage would be necessary. It would be difficult to prescribe the frequency accurately but an estimate could be twice or three times a day. The frequency of coverage would also depend on the type of reporting requested by an international body or parties involved in the conflict and the time element involved in actions to be taken based on the report.

171. A crucial element in this connection would be the response time between the initiation of action by ISMA and the submission of a report by it. The last response demanded of an ISMA would require dedicated data transmission/reception facilities, command and control systems for satellite sensor operation, and sophisticated data processing and analysis facilities. Since capsule recovery of films exposed in a close-look satellite would involve time delays and technology developments indicate the feasibility either of on-board scanning of film or suitable solid state imaging systems supported by high bit rate telemetry transmission and reception, technology availability would affect time response of this system. If on-board film scanning is envisaged, and if it is decided that the transmission to the Earth needs special safeguards by encrypted telemetry the necessary decryption after reception by ground stations could entail a certain time delay. In order to cover an area as requested, an ISMA would also need the capability of "launch on request", to supplement coverage by satellites in orbit. Additionally for critical, timely manoeuvrability of the satellite, communication and command from the operating centre to the satellite either through ground stations in the line-of-sight of the satellite or through two suitably separated geosynchronous satellites would be required if the satellite is out of range of the operating centre. The availability of photo-interpretation staff of the highest professional abilities in conjunction with sophisticated computerized, image processing equipment would influence time response of down-stream activities.

(d) Auxiliary data

172. A considerable volume of auxiliary data would be necessary for the crisis monitoring function of an ISMA. It would need timely information for initiation of image acquisition during the pre-crisis and crisis periods. Weather satellite data for analysis of cloud-free scene availability would be necessary. Further, a meaningful analysis of satellite imagery over a crisis area, the Agency would need information on strengths, military hardware, military installations and details of training exercises of the Army, Navy and Air Force of various States. This would be necessary, in particular, to identify training exercises from deployment in war of units belonging to the services.

(e) Monitoring limitations

173. For crisis monitoring, the effectiveness of an ISMA would be limited by its technical resources which have a bearing on coverage frequency and image analysis. Launch vehicles in sufficient number which would place heavy payloads in appropriate orbits would be necessary. Further, data transmission, reception and analysis facilities with fast response would be needed. Another limitation would arise from the fact that satellite imagery would yield significantly supportive, though not exclusive, information on crises obtained from authorised sources.

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## III. TECHNICAL FACILITIES NEEDED FOR AN ISMA

### (a) General

174. Above technical missions and the type of satellite data needed for an ISMA to fulfil these missions have been defined. The technical facilities needed on the ground are discussed below. Various possible legal and economic constraints are not considered in the sections.

175. As stated in the Introduction, the first stage in the evolutionary process of an ISMA would be processing and disseminating information and data made available to an ISMA by States which operate surveillance satellites. Section A, therefore, deals with an Image Processing and Interpretation Centre (IPIC) that would have to be established under Phase I.

176. Various subsystems to be incorporated in Phase I would, however, more or less be governed by the needs of ISMA in its final phase. Section B deals with Phase II in which an ISMA may be expected to have ground stations working with national satellites. These stations would also be needed in Phase III where an ISMA would operate its own satellites. Section C deals with the space segment that would be needed by an ISMA in Phase III.

## A. Image processing and interpretation centre (IPIC)

### (a) General

177. An IPIC of the Agency should be able to handle area surveillance data with resolution of between 3 and 5 m as well as close inspection imagery data with very high resolution of around 0.5 m. The discussion at this stage would be limited to optical data (e.g. data acquired by imaging sensors in the optical or near infra-red region of the electromagnetic spectrum). The data input to IPIC would be digital (or analog) electrical data, and/or photographic data (monochrometric and/or colour and/or multiband photographs), and map data. The data output would be digital data products in raw, processed and analysed forms, and photographic products (raw data, processed data and analysed data).

178. The computer subsystem would be the central facility in the IPIC. It is anticipated that even for the case when input data are in photographic form, computer systems would be used for correction purposes and also for image enhancement, image processing and mensuration. In case of multispectral data (either in the form of multiband photographic data or MSS data) computer methods would also be needed for the purpose of multispectral analysis using various pattern recognition methods.

179. The IPIC facility may functionally be subdivided into data processing, data analysis and data management subsystems which are discussed below.

### (b) Data Processing Subsystem (DPS)

180. The Data Processing Subsystem (DPS) would convert the input raw data (in electrical or photographic form) into user data products by performing the following functions:

- conversion of photographic and cartographic data to digital data,
- conversion of electrical data streams required for satellite-to-Earth transmission to a format convenient for human or machine use,

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- compensation of the various radiometric and geometric errors introduced in the acquisition phase,

- production of output products (photographic and digital data products).

181. Most conversion and correction functions could be performed on a General Purpose (GP) digital computer. For the implementation of various correction and processing algorithms which are well proven, it is more cost effective to use special purpose hardware subsystems; a GP computer could be utilized for computing correction functions and for performing subsystem control.

182. Data formatting. The first element of the data formatting function is synchronization of the data stream to the follow-on equipment. Subsequent formatting operations depend upon the particular sensor, the format of the data stream output from the reception subsystem and the requirements of the correction and recording equipment which follow.

183. Data correction. Data acquired by satellite systems are subject to a variety of errors and imperfections. Radiometric errors result from variations in sensor sensitivity, atmospheric effects, sensor geometry, calibration system; geometric errors result from variations in satellite attitude and orbit and rotation of the Earth. A major function of the DPS would be to correct/reduce these errors.

184. DPS functions. The preprocessing subsystems should in addition have the following functional requirements:

- acquisition of orbital data for annotation and processing,

- processing of satellite housekeeping data to produce calibration tables,

- acquisition of reconstituted attitude data (from organizations operating the satellite) or reconstitution of attitude from housekeeping data for annotation and processing,

- calibration and correction of data for systematic errors introduced by the acquisition system,

- rectification of data to standard projection and/or inclusion of corresponding grid,

- introduction of media characteristics for imagery products (photographic and similar products),

- editing and annotation of imagery data for distribution and archiving.

185. Many options would be available when defining the processing subsystem of a DPS at the stage of design of an IPIC. An important factor influencing such a design would be the total permitted time lag between data acquisition and data distribution. Another important factor would be the balance between computer hardware and software. Hardware solutions give faster functions while often limiting flexibility.

(c) Data Management Subsystem (DMS)

186. The Data Management Subsystem (DMS) of an IPIC would have the following functions:

- data reproduction

- data storage,

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- data archiving,
- data cataloguing,
- data security, if so decided,
- data dissemination (open or restricted according to considerations set out in Chapter II).

187. The disseminated data would be reproduced either as "hard" (or permanent) images (film products, inkjet images) or magnetic tapes. Data quality control would naturally be a very important function for the DMS facility. Equally important would be data security involving technical facilities used by DMS. The main subsystems of DMS would be composed computers and photolab facilities.

188. It should be stressed that the size of the DMS facility would be very much dependent upon the data dissemination policy of an ISMA; in particular whether an ISMA should disseminate raw data to all ISMA members. This problem must be seen in the light of legal considerations dealt with in Chapter II.

(d) Data Analysis Subsystem (DAS)

189. The function of the Data Analysis Subsystem (DAS) would be to convert the satellite data into information of interest for the ISMA tasks. Manual (visual) photo interpretation is believed to be important; computer-aided interpretation would, however, with time be more and more important. Manual interpretation would be aided by analog devices such as simple light tables and eye glasses, travelling microscopes, microdensitometers and optical colour (additive) viewers (for multiband photography).

190. An advantage of computer-aided interpretation and analysis is, however, that a variety of functions become available when dealing with digital data:

- density slicing,
- contrast enhancement,
- noise cleaning,
- linear filtering (including edge enhancement/detection),
- pseudocolouring,
- composite image production (multiband images or MSS data),
- image and data (map data) integration,
- "automatic" change detection,
- "automatic" feature detection,
- object detection,
- multispectral analysis (multiband or MSS data),
- scene analysis using auxiliary data (map data and other).

191. Although several different structural schemes would be used for designing the DAS computer system, it is believed that the system should incorporate a number of work stations with interactive displays (interactive in terms of programme control), image display, trackball (or similar) facility, as well as feedback of image features

back to programme input). Since various processing algorithms as well as analysing algorithms (e.g. MSS classification) have to be performed pixelwise (or near pixelwise) over the entire picture, several processing functions should preferably be implemented in hardware.

192. The technical design of the DMS should be such that it takes account of the options arising from legal implications which are dealt with in Chapter II, particularly those relating to access and dissemination of raw data and analysed data.

## B. The ground segment

### (a) General

193. In the evolutionary process foreseen as possible for the establishment of an ISMA, the Agency would be expected to have its own ground receiving stations in Phase II. What follows is a brief discussion of these receiving stations for acquiring satellite imagery data which will also be required in Phase III when an ISMA operates its own satellites.

### (b) System configuration

194. The following subsystems are needed for a complete ground station facility:

- receiving station(s),
- mission planning facility,
- operations control centre,
- data processing facility,
- tracking and command subsystems.

195. The organizational size, on the other hand, would depend upon the total workload, e.g. number of spacecraft and sensors, data acquisition volume, etc.

### (c) Receiving station

196. In the case of an ISMA having access to space segments operated by other States/organizations, the ground stations would function purely as receiving stations (cf. Landsat receiving stations being operated within Earthnet). Such a receiving station would consist of the following subsystems:

- antenna,
- microwave receiver,
- wideband demodulator,
- bit synchronizer,
- computer for system control,
- storage equipment (HDDT magnetic tape recorders).

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197. The receiving system would be under computer control; all necessary orbit information would be fed to the computer in advance and the computer would drive the antenna to the appropriate receiving position. When the signal from the spacecraft is received, it is utilised for precision tracking of the satellite while receiving and recording data.

198. The satellite may transmit its data to a relay (communication) satellite (TDRSS) which retransmits data to a ground receiving station co-located with the IPIC.

199. The data transmission from the receiving station to the IPIC could be carried out in several ways; either by physical transport of data (film and/or HDDT) or by using communication networks, (either land-based or space-based).

(d) Command and control system

200. When an ISMA can operate its own satellites or has (active) access to satellites operated by other States/organizations, facilities other than those for receiving functions would be needed, such as a mission planning subsystem and an operations control centre.

201. The mission planning subsystem would provide planning of data acquisition taking into account, for example, the following:

- data request (including time conditions),
- available satellites (including orbit pattern),
- available sensors,
- weather conditions.

202. The mission planning subsystem, therefore, should have available meteorological information, preferably through a special meteorological support unit. This meteorological unit would need to obtain meteorological data and information from the WMO WWW system.

203. The operations control centre would provide control of all satellites belonging to an ISMA (Phase III) and sensor operations required to satisfy the objectives defined by the mission planning subsystem. The control centre should have its own computer facilities for detailed mission planning and execution including processing of spacecraft telemetry, generation of command and system scheduling. Satellite ephemeris would be derived from telemetry data and from data acquired by tracking stations. These data would also be transmitted to the receiving station subsystem for producing image annotation data for identification.

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C. The space segment

(a) General

204. In a third phase an ISMA would have its own satellites. This section contains a brief discussion of the space segment which would have the following subsystems:

- platform,
- payload,
  - . telemetry,
  - . manoeuvrability functions,
  - . sensors.

205. Even in the case of ISMA-owned space segments, it is considered that the launching capacity is to be purchased from other organizations. Spacecraft design and fabrication could also be appropriately contracted. However, for this phase in the evolution of an ISMA, it may be essential for an ISMA to have its own competence in specifying space segment operational characteristics, including sensor characteristics. Since the sensor systems would be very crucial for the entire Phase III ISMA operations, it may be desirable for an ISMA to acquire competence in sensor design test and calibration facilities.

206. It may also be possible that the total space segment could be made available to an ISMA from national organisations.

(b) Launching capability

207. Until recently, only the USA and the USSR were able to launch the heavy satellites necessary for surveillance but several other nations are now developing a similar capability. By the time an ISMA could be established and becomes operational, there is no doubt that several countries may be able to offer their services to launch ISMA satellite platforms.

(c) Satellite orbits

208. The question of orbital parameters can only be answered when the mission is fully defined. The following parameters are of interest:

- temporal coverage required (frequency of observation or scene availability),
- local time of observation (applicable to cases when full coverage is not needed).
- orbital altitude (defining IFOV for the area being observed).

209. Two different kinds of orbits may be considered, polar orbits (orbital plane inclined at 90° to the equatorial plane and geostationary orbits (about 36,000 km above the equator).

210. Full coverage can only be had if several satellites are used. For example, at least three satellites would be needed for meteorological observations from a geosynchronous orbit to get a complete coverage of the Earth's surface - except for the polar regions. In theory several satellites would be needed for surveillance of the Earth's surface from low altitudes with satellites in polar orbits. However, in practice a much lower scene availability has to be accepted so that two to three satellites in a year would be sufficient. If a satellite observation system is to be used for early-warnings of attack, the required scene availability would be

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determined by the mobility of the attacking forces and it is inversely proportional to the distance from national borders. The required scene availability could be of the order of one hour. A few scenes per day might be sufficient if evidence of violation is required.

211. If, for example, orbits other than polar orbits (i.e. orbital planes inclined at angles other than 90° to the equatorial plane) are considered, then the entire globe cannot be observed. On the other hand a better coverage is obtained for the zone accessible from the satellite. As an example an orbital inclination of 30° permits imaging capacity to about 37 degrees northern and southern latitudes. A circular orbit with 900 km altitude gives a period of 103 minutes, and one satellite in such an orbit would pass over the same point on the Earth every 24 hours.

212. Necessary scene coverage could be obtained in several ways. One would be to use several satellites. Another method would be to change the orbital characteristics of a satellite in such a manner that, within a given time period, the space craft makes several passes over the area of interest. In this way, scene availability for a given area may be increased by accepting smaller area coverage.

213. The scene availability is not the only parameter of importance in orbit selection. For high resolution imagery, observations would have to be made mostly in the visible region of the electromagnetic spectrum, and the local observation time would also be very important. In the so-called sun-synchronous orbit, the orbital parameters are chosen so that the satellite track passes a given point on ground at the same local time (and therefore at approximately the same solar elevation). Photo interpretation and also computer analysis would be simplified for imagery acquired from sun-synchronous orbits.

214. Another important parameter is the IFOV of the sensor. Since the IFOV (linear) size is directly proportional to the satellite altitude, high resolution images cannot be obtained for high altitude orbits. This rules out the use of geostationary orbits except for very low resolution data (of the order of several hundred metres in the visual band).

215. The question of choice of orbital element and satellite temporal coverage is a complicated one. Purely from the point of view of information, a complete coverage might be preferred. This would, however, have drastic consequences in the design and operation of both the space and ground segments of an ISMA. In an actual space observational system compromises would have to be made and an optimal trade-off between segment design, scene availability, data volume and image resolution would become necessary.

### (d) Platforms

216. The development in space technology has resulted in many different satellite platforms. The design of specialised platforms for specific purposes has the advantage of each system being very efficient from technological points of view. On the other hand, the use of "standard" platforms has the advantage of lower costs provided the same platform design can be used for several missions. The trend now is to use standardised platforms. It is, therefore, anticipated that the platforms needed for an ISMA operational satellite would be of the standard or multimission type. Such a platform should be capable of carrying different payloads for different missions and it must, therefore, be designed for the "worst" case with regard to parameters such as weight, volume, power, etc.

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217. Mission-independent subsystems for support and orbital control of a satellite platform would contain:

- support subsystems,
  - . structure
  - . thermal control
  - . on-board power
  - . on-board data handling
  - . tracking telemetry and command
- orbit control subsystem,
  - . attitude control
  - . orbital control (including facility for manoeuvring)

218. The on-board power system would normally be designed around solar power panels (or a nuclear power generator). A power of 1 KW would be sufficient to drive passive sensors while more power would be needed for active sensors like radars.

219. The functions of the communication and data handling subsystem would include housekeeping telemetry transmission, command reception from ground station (or via a relay repeater satellite) and on-board data handling. The on-board computer would be remotely programmable, and manage all on-board functions like:

- payload activity management, instrument calibration, instrument pointing,
- modification of the satellite control functions (like thermal control, orbit correction) to compensate for any observed discrepancies between predicted and observed performance,
- modification of control functions for on-board subsystems to compensate for changes due to ageing (solar cell output, tank levels),
- modification of telemetry format to match monitoring requirements dependent upon phase of operation (altitude and orbit data acquisition, image acquisition),
- updating of the log and incident report register.

220. The attitude of the platform should be stable to ensure good image quality. This would be achieved by controlling certain relations between the attitude angles and their speeds. The attitude control subsystems would normally consist of sensors recording various attitude parameters, electronics to receive signals from the attitude sensors and electronic systems which generate controlling signals for actuators which would change the attitude parameters.

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221. The orbital control subsystem would ensure that the required orbit is achieved after launch and thereafter the satellite is maintained in that orbit. The subsystem would achieve this by acquiring post-launch attitudes and by applying adjustment using on-board thrust capacity (e.g. hydrazine system).

222. If the altitude of a satellite in its orbit is lowered and/or it is manoeuvred in its orbit, appreciable energy is needed for the orbital control system compared with the energy needed for finer orbital adjustments.

(e) Payloads

223. In addition to the mission-independent subsystems described above the satellite would also contain the following mission-dependent subsystems or the payload:

- data acquisition (imaging) instruments,
- imagery data telemetry.

224. Data acquisition instruments that would be of primary interest for ISMA operations would be:

- optical and IR imaging sensors (multiband or multispectral),
- microwave imaging radiometers (multispectral),
- microwave imaging radars (SAR-type),
- microwave precision altimeter,
- nuclear explosion detectors
- radio signal receivers ("electronic intelligence" acquisition receivers).

225. Only the use of optical (visual and IR) imaging sensors would be discussed here since, firstly, it is believed that data from such sensors might be the first data made available to an ISMA. Secondly, although such data are by no means the only data of interest to an ISMA operation they are, nevertheless, considered to be of primary importance in many monitoring and verification tasks.

226. As mentioned earlier, the ISMA activity would be focussed around two different types of observation systems:

- observations with imaging sensors in visual and IR with resolutions in the range of about 1.5-2.5 m IFOV (visual) and about 15 to 25 m IFOV (IR) ("area surveillance"),
- observations in visual with visual imaging sensors in the range of 0.2-1 m IFOV or better ("close-look" imaging),
- radar observations with resolution in the range of 10-20 m IFOV.

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227. The purpose of the area surveillance would be both to acquire a data bank for describing in particular the "background" (terrain background and fixed installations) and to act as a reporter of indicators of "abnormal" activities. The purpose of the close-look data would be to gather information concerning specific disputes, to verify some aspects of the implementation agreements in arms limitation and/or to gather information on military (and non-military) activities before and during crisis situations.

228. It would in principle be possible to use the same camera system for both area-surveillance and close-look by utilizing different satellite altitudes (200 to 1,000 km). A disadvantage of low altitudes would be atmospheric drag on the satellite which would reduce its orbital lifetime. This would call for frequent replenishment of the space segment to meet coverage requirements. It would, therefore be desirable to use satellites at higher altitudes (around 500 km), having sophisticated and costly cameras for close-look imaging.

229. The number and type of sensors and their resolutions would determine the payload characteristics and the characteristics of data downlink system for image data transmission. Another important systems consideration would be procedures for handling the acquired data. For example, the following options would be possible:

- direct transmission of data in real time from spacecraft to ground station(s).
- direct transmission of data in real time via relay satellite(s).
- storage of data for later transmission (choice of data speed possible).

230. Another aspect to consider as regards data transmission is the question of data encryption. If it is decided that encrypted transmission is needed to preserve data security, encrypting keys would have to be distributed to those ground stations eligible to handle data from ISMA satellites.

231. If it is decided that all stages of the operation of an ISMA should be confidential this would have technical as well as organisational implications. Since any telecommunication system may be exposed to eavesdropping, systems which handle confidential information need some type of cryptographic security. The procedures would ensure that information should be available only to the authorised persons or organizations. Digital data streams may be enciphered by translating the stream element to element or group of elements in accordance with some law, known only to the sender and the legitimate receiver. There is only one type of completely safe enciphering system, namely the one-time-key. In this case the code is randomly generated and used only once. Such systems are not very useful in multiuser networks and for large amounts of information. A more practical method is one in which enciphering equipment is used to generate the translation law in a deterministic process governed by the "key" which is known only to the sender and the legitimate receiver. Depending upon the cryptoanalysis capabilities of the unauthorized user, the cryptographic security system if it were decided that an ISMA would need such a system would be more or less sophisticated.

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## D. Technical Aspects of the Evolution of an ISMA

### (a) Introduction

232. In previous sections discussions have been presented of the technical and organizational aspects of a well established ISMA. In practice, however, an ISMA may evolve gradually over a period of time.

233. Since the output product of an ISMA would most likely consist of a factual report giving an interpretation of data acquired by satellite sensors, the IPIC would be of vital importance for the entire organization. Based on Section III above, the group was of the opinion that the following evolutionary phases would appear feasible:

- Phase I:
  - development of IPIC facilities using imagery data available from existing civilian satellite systems for training, and in imagery data from possible future civilian systems.
  - utilization of other imagery data made available to ISMA from national (non-civilian) satellite systems,
- Phase II:
  - development of ground stations for receiving data acquired by civilian satellite systems of relevance and by non-civilian satellite systems, as available (and also, if applicable, for receiving non-civilian data),
- Phase III:
  - development of ISMA space segments for operational ISMA monitoring satellites.

234. It should be pointed out, however, that other evolutionary phases would be conceivable. One option would be to start with Phase I and then to implement Phase II and Phase III at the same time.

235. Starting with Phase I, the establishment of an IPIC might be considered as a natural way of starting the activities of an ISMA. This phase could also be viewed as a necessary training period for interpreters and analysts and for establishing the required procedures, methods and standards.

### (b) Phase I

#### (i) Data availability

236. In this phase, an ISMA would be dependent upon data delivery from other (national) satellite systems. The following data sources may be considered:

- data from existing meteorological satellites,
- data from existing and planned earth resources satellites: USA (Landsat), USSR, ESA, France (SPOT) and others,
- previously recorded satellite data (historical data and training data (Skylab, etc.)).

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237. In all likelihood the above data would very likely be acquired by an ISMA without difficulties and could be used for the purpose of training and establishing of procedures and standards. The data would however be limited to IFOV in the range of 10-20 m and such data therefore would be of limited interest for the monitoring and verification functions of an ISMA.

238. Following are national systems in which fine/high resolution data are generated:

- USA military reconnaissance satellite data,
  - area-surveillance (resolution 3-5 metres)
  - close-look (fine/high resolution, about 0.5 metre)
  - radio surveillance ("electronic intelligence")
  - high resolution radar data (from 1985?)
  - IR data (high resolution) (from 1990?)
- USSR military reconnaissance satellite data,
  - area-surveillance (medium resolution)
  - close-look (high resolution)
  - radar surveillance
- Other

  improved SPOT (radar and optical) (from 1985?)

239. From a technical point of view, some data could be delivered to an ISMA which would be just adequate to its functions. The delivery of the data from national (and other) organizations in this phase could be made in the following ways:

- physical delivery of photographic images,
- physical delivery of imagery data stored on magnetic tape,
- transmission *via* data network (including satellite (INTELSAT) network).

Technical details and quality specifications would be spelt out in agreements between the ISMA and States delivering data.

### (ii) Technical facilities

240. While the facilities needed for the IPIC activity have been discussed in III.A. above, and these can be defined as :

- organization and infrastructure,
- technical facilities,
- manpower.

241. These facilities could best be discussed starting from the nature of the work to be undertaken:

- equipment procurement, recruitment of staff, administrative and financial support,
- development of methods, procedures and routines for standardization, preprocessing and thematic processing,
- development of routines for checking of methods and results by reference to ground truth,
- maintenance of archives and data banks,
- processing and analysis of general surveillance imagery data for building up historical data banks,
- processing of general surveillance data over certain areas (for training; on request),
- photo-interpretation of data with high resolution for various purposes like eliminating ambiguities or doubts, surveillance of zone of temporary crises etc.,
- editing and distribution of output.

242. The organization could therefore also reflect the tasks above and contain the following elements:

- archives and data banks,
- photographic laboratory,
- computer processing and photo interpretation,
- computer facilities.

243. The total technical (and manpower) resources needed would be closely related to the anticipated workload and responsibility of an ISMA at this stage.

### (iii) Data volumes

244. The volumes of data to be processed, analysed and interpreted would be very difficult to establish. It is, however, possible to present various scenarios based on reasonable assumptions.

245. Area surveillance:

surveyed area: 10 per cent of the Earth's land area = 15 x $10^6$ sq. km

image (scene) size: 100 x 100 sq. km

Frequency of observations: twice a year

Number of scenes per year: 3,000

Number of scenes per month: 250

246. Close-look surveillance:

surveyed area: 10 x 200 sq.km

image (scene) size: 10 x 10 sq.km

Frequency of observation: once a day

Number of scenes per day: 20

Number of scenes per month: 600

247. The total number of scenes to be handled and interpreted under these assumptions would therefore be about 850 per month.

(iv) Establishment of procedures

248. The establishment of standards, methods and practices for the work being performed by ISMA would be considered very important for the reliance which will be put on ISMA. Some of the important questions that may be considered with regard to an ISMA are:

- data acquisition and dissemination,
- access to data and data security,
- end result,
- analysing and interpretation practice,
- time delay for processing and interpretation.

249. From a technical point of view the following options are available:

- free dissemination of raw primary data,
- free dissemination of corrected and calibrated data,
- restricted dissemination of data to parties to be determined.

250. The choice of methods for data dissemination as well as of a date security system would have technical implications for an ISMA deriving from legal implications discussed in chapter two.

251. An ISMA action would include data acquisition, which might take place before or when the action is requested, data processing and data analysis. The end result of an action should preferably be in the form of a factual report stating the findings obtained through the analysis or interpretation.

252. Analysis or interpretation practice are of vital importance for an ISMA. It is important that competent photo- interpreters with experience in military photo interpretation participate in the analysic procedure Two separate and parallel interpretation teams should be set up so that their findings could be cross-checked. Since military photo interpretation often is a complicated task, it is necessary that the interpretation be made against ground truth whenever it is available. Therefore data banks containing e.g. historical data, maps, terrain characteristics, would have to be developed. Also, interpretation has to be made against data obtained from sources other than satellites (including data in non-imagery form) such as reports, published works, or any other form of public information.

253. It would also be important to define procedures to avoid or minimize interpretation time delay. In many actual cases, short time delays for the ISMA operation and reaction is a prerequisite for the confidence to be put on the organization.

(v) Manpower resources

254. The manpower resources needed for Phase I (IPIC) can be estimated with reasonable accuracy. An approximate breakdown according to the grouping defined above would give the following result:

| Group task | No. of people | |
|---|---|---|
| | high | low |
| Administration and support | 50 | 40 |
| Development and checking of methods | 25 | 15 |
| Archives and data banks | 30 | 20 |
| Computer processing and analysis | 2 x 30=60 | 2 x 25=50 |
| Photointerpretation | 2 x 20=40 | 2 x 15=30 |
| Computer systems | 30 | 20 |
| Photographic laboratory | 25 | 15 |
| Editing and distribution | 25 | 15 |
| total: | 285 | 205 |

(vi) Prospects

255. In the establishment of an ISMA, if a gradual three phase process is adopted, then the usefulness of Phase I would be in training members of IPIC and in establishing standards and procedures for handling, processing, analysing and interpreting satellite imagery data. It should be pointed out that the data from the civilian satellites available today are of limited interest for the ISMA. However, future civilian systems may well produce images with finer/higher resolutions of the order of 10-20 m IFOV and these may be of some value for area surveillance.

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Moreover, the effectiveness of an ISMA in monitoring crises and verifying arms control or disarmament agreements would be all the greater if the Agency began to receive adequate data from national (non-civil) systems during this initial phase. Inherent, even then would be issues like timely availability and data accuracy.

(c) Phase II

(i) Ground Stations

256. During this phase an ISMA would receive data from national satellites or from satellites belonging to international organizations (e.g. ESA). This phase should not be considered as an obligatory phase in the development of ISMA. It would, however, be of interest for several reasons:

- it would constitute a natural step in the gradual development of an ISMA,
- an increasing number of States would contribute to the technical operation of ISMA,
- it would improve the time factor in data access for ISMA.

257. This phase could be implemented in various ways such as:

- ISMA owned and operated ground stations,
- ISMA personnel on national ground stations,
- use of relay satellite(s) to ISMA ground stations,
- combinations of above solutions.

258. The kind of data of interest to ISMA in this phase would be, in addition to open data from civilian satellites, area-surveillance data and close-look data from military satellites. Both imagery and non-imagery data would be of interest. It would be important that the degree of coverage (either by ground stations alone or by a combination of ground stations and relay satellites) should be as complete as possible.

259. When non-civilian satellites are used as data sources, data transmission may have to be encrypted. It may also be worthwhile to consider introduction of a kind of "ISMA standard transmission modules". National satellites could then be equipped with such modules for (standard) transmission either to ISMA ground stations or to national ground stations having ISMA personnel and/or ISMA receiving equipment.

260. The kind and number of ground stations for this phase may depend upon:

- number of satellites co-operating in the ISMA receiving network,
- combinations of on-board storage and/or relay satellites,
- the mode of data acquisition (continuous, on request, etc.).

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261. Since Phase II is expected to be preceded by Phase I with an ISMA-operated computer centre, the main investment for this centre would already have been made. Some extra investments may be needed for the IPIC station depending upon the anticipated workload and data volume in Phase II compared with Phase I. The largest investments, however, would be in the ground stations system.

(ii) Data transmission to IPIC

262. The data acquired by ISMA receiving stations would have to be transmitted to the IPIC. This could be achieved in one of the following ways:

- physical delivery (film, magnetic tapes),
- microwave digital transmission (including INTELSAT),
- combinations of physical delivery and digital transmission.

263. At this stage, the comments made in paragraph 235 regarding the technical implications of certain legal options also apply. It will be noted, *inter alia*, that, to the extent that the technical implementation of Phase II would involve the transmission of a considerable quantity of data by radiocommunications, data security requirements might possibly necessitate the use of appropriate technical means to make such transmission inaccessible to unauthorized third parties.

264. If one (or the main) ground station could be situated in the vicinity of the IPIC station, many of the problems of data transmission and delivery would be easier to solve. In this case, direct (digital) access to a computer storage bank could be arranged.

(iii) Prospects

265. Phase II in the evolution of an ISMA could be sensitive from many points of view, since this phase would be dependent upon the co-operation and goodwill of States for making available (limited) data from their own national satellite (non-civilian) systems. The degree of utility of the received data would also be determined by the accuracy of the data and the time element of availability.

(d) Phase III

(i) Technical feasibility

266. It has been assumed so far that in the first two phases of an ISMA the Agency may be able to carry out its mission without having access to its own space segment, since data in these phases could be obtained from national systems. The access to satellite imagery data from space segments entirely under the control and supervision of the Agency may seem both consistent with the policy of an ISMA and as a useful supplement of the arrangements of Phase I and II described above since in Phase I and II the Agency would depend on the co-operation of a country or countries for access to data. Furthermore, one difficulty involved in the use of national space systems may be the conflicting requests from ISMA and from national bodies with regard to image and data acquisition. Data from national satellites may often be routed through national services which are not bound by rules of conduct of an ISMA, this could involve risk of indiscretion and/or manipulation of data. The development and deployment of ISMA space resources would make it possible to adapt the systems optimally to the missions of an ISMA which is not necessarily the case with national systems. These difficulties could be solved with a space segment controlled by the Agency itself.

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267. The space segment of an ISMA in Phase III could consist of:

- area surveillance system including one or more satellites with resolution of about 3-5 m with synthetic aperture radar with resolution of about 15 m on one or more satellites.
- close-look satellite system with resolution in the range of 0.5-1 m,
- nuclear explosion detection system.

268. There could be several ways of implementing such a system:

- delivery to an ISMA of a space segment already developed elsewhere,
- development (by nations) of new segment specifically designed and adapted for ISMA needs,
- in house development by an ISMA required segments.

269. Between about 1985 and 1990 several States may be able to offer space systems, at least of the type needed for area-surveillance. The close-look type of satellite, requiring special cameras with large focal length or other devices, manoeuvring capability and very high rate of telemetry may prove difficult but not insoluble, problems.

270. It may not be necessary for an ISMA to have its own launching capability. In the time scale considered for Phase III, launchers could be available from both the USA and the USSR and other member States (Brazil, China, ESA, France, India and Japan).

271. If the co-operation and goodwill of States, which is a prerequisite for Phase II of the evolution of ISMA, is not available, it may be necessary to consider the direct transition of an ISMA from Phase I to Phase III.

(ii) Technical facilities

272. The technical facilities needed for this phase have already been discussed above in paragraphs 225-231 :

- area-surveillance satellite system consisting of one (or several) multiple pass satellites in sun-synchronous orbit with low manoeuvrability and altitude of 600-900 km, with the following instruments:
  - . multispectral scanners in optical and IR with IFOV of between 5 and 50 m.
  - . radar with an IFOV in the range of 5-10 m.
- close-look satellite system in medium (parking) orbit (500 km) and with high degree of manoeuvrability leading to low altitude (about 200 km) excursion and with camera (multiple band) of large focal length with either solid state sensors of film recording (in latter case data conversion by film scanning) with an IFOV in the range of 0.3-1 m,
- facilities for tracking, command and control,
- ground stations for data telemetry,
- image processing and interpretation centre.

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273. The technical faciaities required for this phase would be complex anu costiy.

(iii) Prospects

274. The prospects for this phase are dependent upon a number of uncertain factors and are therefore difficult to estimate. The advantage of ISMA operating its own space system is that the system can be fully adapted to the requirements defined by ISMA missions and the Agency has full control of all the various stages from data acquisition to image transmission and image interpretation.

## IV. OTHER TECHNICAL CONSIDERATIONS

275. It should be of importance to an ISMA to have a technical body qualified to provide competent professional services to the management in relevant areas of space technology and in the evolutionary phases and operate and maintain required facilities and supervise the research and development work that would be essential for the Agency.

276. The Agency's technical facilities should, primarily, be obtained from technologies developed by member States or other United Nations Members or countries or international organizations engaged in space activities. An ISMA may nevertheless find it advantageous to carry out research to improve some of the technologies thus obtained. The Agency should, especially in its Phase III, be in a position to organize, supervise and manage the work on the design and development of its space segment.

277. The functions of an ISMA's technical service could be:

- optimization of the technical solutions adopted for the systems to be acquired or developed in all the phases of evolution; update of systems and technology as needed;
- carrying out and managing the work on developing and setting up these systems; and
- maintenance, renewal and effective operation of the systems;

Qualified bodies or industrial firms from member countries within the Agency or outside it could participate in this work, by means of contracts or other suitable legal instruments. ISMA's technical service, for its part, should have a number of design offices and some laboratories specializing in various technical sectors:

- space vehicles and systems;
- sensors;
- data processing;
- new technologies.

278. The results of the work carried out by ISMA on its own account (inventions, technical information, etc.) could be made available to member countries under conditions to be determined. In this matter, there are numerous precedents to be found in the constituent legal instruments of international technical organizations such as the European Space Agency.

279. For the purpose of carrying out its functions, ISMA will be in possession of a considerable amount of earth observation data and will have the technical facilities to acquire such data at specific times and places. The data and technical facilities will of course be specially adapted to the tasks of the Agency. It is nonetheless useful to point out that these data and facilities could in some cases be used for other applications, under conditions which would have to be specified.

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## CHAPTER TWO : LEGAL IMPLICATIONS

### I. General legal considerations relating to monitoring by satellite

280. Real accomplishments in the efforts to slow down the arms race, thus helping to reduce international tension and creating among States a climate of trust, have been few and far between. As the Final Document of the first special session of the United Nations General Assembly devoted to disarmament soberly notes: "Mankind today is confronted with an unprecedented threat of self-extinction arising from the massive and competitive accumulation of the most destructive weapons ever produced ... . This situation both reflects and aggravates international tensions, sharpens conflicts in various regions of the world, hinders the process of détente, exacerbates the differences between opposing military alliances, jeopardizes the security of all States, heightens the sense of insecurity among all States, including the non-nuclear-weapon States, and increases the threat of nuclear war." 2/

281. The establishment and the conduct of activities of an intergovernmental organization, such as ISMA, dedicated to the promotion of international peace and security and to the enhancement of confidence among States, should be in accord with international law.

282. The establishment of an ISMA would be fully consistent with the Charter of the United Nations, in particular with Article 1 of the Charter under which Member States have agreed to "take effective collective measures for the prevention and removal of threats to the peace ... and to bring about by peaceful means, and in conformity with the principles of justice and international law, adjustment or settlement of international disputes or situations which might lead to a breach of the peace ... and to take other appropriate measures to strengthen universal peace."

283. It is worth noting that the comprehensive proposals for "general and complete disarmament" submitted by the USSR and the United States in 1962 to the Eighteen-Nation Committee on Disarmament assigned a central role in the implementation of the disarmament programme to an International Disarmament Organisation (IDO). Similar proposals were made to the CCD by the Netherlands, Sweden and Yugoslavia in 1972 followed by another proposal in the CCD by the Netherlands in 1973. In the discussion of these proposals various techniques for verification, including space technology, were discussed. Other institutional proposals were put forward by the Netherlands as well as Sri Lanka to the Special Session of the General Assembly devoted to disarmament in 1978 and by Sweden to the General Assembly in 1979.

284. In the proposals made by the USSR and the United States, IDO was to have been established within the framework of the United Nations and charged with the verification of the obligations undertaken under the agreed disarmament programme. Other States have also at different times expressed their interest in or support for the idea of an impartial, international organization entrusted with the monitoring of multilateral disarmament agreements. Latin American nations parties to the Treaty for the Prohibition of Nuclear Weapons in Latin America, of 14 February 1967, went a step beyond and have established a special monitoring agency to ensure compliance with the provisions of that Treaty.

285. There is a growing feeling among States that the existing arms regulation process urgently needs revitalization and improvement and that the United Nations should play a more active role in the verification of disarmament and arms limitation agreements. In the light of recent developments in the field of arms regulation, the need for institutionalization of the verification process is becoming increasingly obvious. The expanding disarmament agenda, the complexity of the issues involved, and the more active participation by a growing number of States in disarmament negotiations serve to underscore this need.

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2/ United Nations Document A/Res/S-10/2, 13 July 1978, hereinafter referred to as Final Document.

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286. The first special session of the General Assembly devoted to disarmament is of great importance in this context. The proposal made at that Session by President Giscard d'Estaing of France for the establishment of an international satellite monitoring agency represents an innovative response to these needs. An illustration of the interest of States in such an organization was provided by the support given by a large majority of States in the General Assembly to resolution 33/71J, of 14 December 1978, which called for a study of the implications of establishing an international satellite monitoring agency. Forty-two Member States co-sponsored the draft resolution, which was adopted by 113 votes in favour, none against, and 13 abstentions.

## (A) The international legal régime governing outer space activities

287. Since activities of an ISMA would cover both outer space and the Earth, they will be governed by the principles and rules of international law, including the Charter of the United Nations and international space law. While the study of the legal status of an ISMA's functions from perspectives of international law would be dealt with under appropriate headings of the report, a brief outline of the existing legal régime of outer space as it may apply to the Agency and its functions is presented in the immediately following paragraphs.

288. Since the establishment of an *Ad Hoc* Committee on the Peaceful Uses of Outer Space in 1959, the United Nations has been the centre for the development of international space law. All the main international agreements regulating various aspects of outer space exploration and use have been negotiated and drafted within the framework of the Committee on the Peaceful Uses of Outer Space (COPUOS). The most important among these agreements is the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies (the "Outer Space Treaty"). The Treaty was signed at Washington, London and Moscow on 27 January 1967 and entered into force on 10 October 1967. As of January 1980, 77 States have become parties to this Treaty.

289. The Treaty incorporates a number of principles, rules and procedures which are applicable throughout the outer space environment. 3/ A general principle, which permeates the document as a whole and which serves to indicate the expectations of the parties, appears in the Preamble of the Treaty. It embodies a recognition of the "*common interest* of all mankind in the progress of the exploration and use of outer space for peaceful purposes". Other more important provisions of the Treaty enunciate the basic freedoms of outer space and celestial bodies, provide for measures aimed at securing safe and orderly conduct of space activities, and prohibit certain military uses.

290. The key principles of the Treaty, as far as the basic legal regime of outer space is concerned, can be found in Articles I and II. Article I declares that outer space, including the moon and other celestial bodies, is "the province of all mankind" and "shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and [that] there shall be free access to all areas of celestial bodies." Under Article II, no part of outer space or of any celestial body is "subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." There is today widespread agreement that the twin principles of freedom and non-appropriation in relation to outer space exist independently of the Treaty, having already acquired the status of customary principles of international law.

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3/ The equatorial countries parties to the Bogota Declaration of 17 January 1977 have stated that the Outer Space Treaty "cannot be considered as a final answer to the problem of the exploration and use of Outer Space" because it was "elaborated when the developing countries could not count on adequate scientific advice" and were thus unable to participate effectively in its drafting.

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291. Article IV of the Treaty contains prohibitions against certain military activities in outer space and on celestial bodies. Because of their potential interest to ISMA the arms regulation provisions of the Treaty are dealt with in greater detail below.

292. Although by Article XIV only States can become parties to the Outer Space Treaty, several provisions of this Treaty apply also in the case when space activities are carried out by States through international organisations participating in the utilisation of outer space. Thus, according to Article VI, "When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization." Article VI is complemented by Article XIII, which stipulates that the substantive provisions of the Treaty shall apply to space activities carried on by States "within the framework of international intergovernmental organizations." However, the resolution of "practical questions" in connection with activities carried out by international intergovernmental organisations is left by Article XIII to the States Parties to the Treaty and the organisation of which they are members.

293. Article XI of the Treaty, urging States to report to the United Nations Secretary-General their activities in outer space and on celestial bodies, also appears relevant to ISMA. Although the call to report "to the greatest extent feasible and practicable ... the nature, conduct, locations and results of such activities" is specifically addressed only to States, Article XI when read in conjunction with Article XIII will require States participating in international organizations to report on activities of such organizations.

294. The question of liability generally covered in Article VII of the Outer Space Treaty is treated specifically in the Convention of International Liability for Damage caused by Space Objects, of 29 March 1972 (the "Liability Convention") which would probably be of relevance to ISMA only in Phase III, when the Agency begins to operate its own satellite(s). In Phases I and II, ISMA is not expected to "conduct space activities" in the sense employed by the Convention. The principal purpose of the Liability Convention is to "ensure ... the prompt payment" of a full and equitable measure of compensation for loss of life, personal injury, loss or damage to property caused by space objects (Preamble and Article I). Article XXII of the Convention provides for the application of the Convention to international intergovernmental organizations. Any such organization engaged in the conduct of space activities can be covered by the Convention if it "declares its acceptance of the rights and obligations provided for in this Convention", if it "declares its acceptance of the rights and obligations provided for in this Convention", and if "a majority of the States members of the organization are States Parties to this Convention" and to the Outer Space Treaty of 1967. The Article further provides for joint and several liability of the organization and those of its members that are States Parties to the Convention. As long as ISMA is not operating its own satellites, the issuance by the Agency of a declaration such as provided for in Article XXII does not seem legally possible.

295. The 1975 Convention on Registration of Objects Launched into Outer Space (the "Registration Convention") also applies both to States and to "any international intergovernmental organization which conducts space activities if the organization declares its acceptance of the rights and obligations provided in this [Registration] Convention and if a majority of the States members of the organization are States Parties to this Convention" and to the Outer Space Treaty of 1967 (Article VII). The major purpose of the Convention is the establishment of a mandatory system of international registration of objects launched into outer space. The system is expected to assist States in the identification of such objects and thus to facilitate the implementation of space law agreements, especially the Liability Convention and the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space. According to Article III of the Convention, the Secretary-General of the United Nations is charged with the maintenance of a Register.

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296. The Registration Convention will be relevant to ISMA only in Phase III, when ISMA acquires its own satellite(s). Until then, the reporting of satellites used by ISMA will be incumbent upon the "launching State". However, ISMA should make certain that the Secretary-General is promptly informed by the launching State that one or more of its satellites are conducting monitoring on behalf of the Agency.

297. The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, of 22 April 1968, similarly, does not seem applicable to ISMA before it begins tp launch its own satellite(s). At that time Article 6 of the Agreement, using the same language as the corresponding provisions of the Liability Convention and the Registration Convention, might become relevant.

298. The latest addition to the developing corpus of international space law is the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Agreement"), adopted by the United Nations General Assembly by resolution 34/68 on 14 December 1979. The major objectives of the Agreement aim at ensuring that all activities on the moon and other celestial bodies be carried out exclusively for peaceful purposes, in accordance with international law, including the Charter of the United Nations, in the spirit of co-operation and in an environmentally sound manner. The Agreement also declares the moon and its natural resources to be the "common heritage of mankind" and provides some guidelines for the mangement of those resources until a more permanent international régime is established. Since the Moon Agreement includes among its provisions prohibitions against certain types of military activity, and as such could be of direct interest to ISMA it will be dealt with below under II (A).

299. The international legal instrument governing all telecommunications both in outer space and on Earth is the International Telecommunication Convention and the Administrative Regulations annexed thereto. In particular, the Radio Regulations contain the necessary provisions for an orderly and efficient use of the radio frequency spectrum and space radiocommunications. The International Telecommunication Convention and its Administrative Regulations have treaty force and are binding on all the Members (at present: 154) of the International Telecommunication Union.

## (B) Observation of the Earth

300. The two major space Powers have been conducting observation of the Earth through the use of surveillance satellites since the early 1960s. Although doubts were expressed during the first decade of space exploration as to the legality of surveillance by satellite, no formal protests are known to have been made concerning such activities. It may be noted that these activities do not fall under the prohibited activities listed in Article IV of the Outer Space Treaty.

301. In the early 1970s, with the advent of remote sensing spacecraft such as the United States Landsat-1, specially designed to monitor natural resources and the environment of the Earth, the question of the legal status of such observation was formally raised in COPUOS. Opinions were expressed by some States that the existing international legal norms did not provide adequate protection of their national interests against this kind of observation. Nevertheless, the beneficial aspects of remote sensing from outer space were recognized and it was pointed out that this new technology could be useful to all countries in areas such as agriculture, forestry, geology, etc. Opinions were also expressed that any problems with regard to remote sensing from outer space could be solved by international co-operation and wide participation in these activities, possibly through an international organization. In response to a recommendation of the United Nations General Assembly contained in resolution 3234 (XXIX) of 12 November 1974, the Legal Sub-Committee of COPUOS, in the spring of 1975, began a detailed examination of the legal aspects of remote sensing from space. The ultimate aim of these deliberations has been and remains the formulation of a set of legal principles to guide States in their remote sensing activities.

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302. By April 1980, a total of 17 draft principles had been tentatively formulated. However, agreement has been reached so far only on the text of a few of the principles, none of which covers the more contentious issues. The debates held in COPUOS have demonstrated that the principal concern of States in regard to remote sensing by satellite is the question relating to dissemination of and access to data and/or information gathered by this type of technology. In this connection there is a divergence of views whether such data and/or information should be openly disseminated or be subject to a régime of prior consent. The views of States on this matter are to be found in the reports of COPUOS. 4/ The results of these discussions may have to be taken into account in the establishment of ISMA.

### (C) Monitoring by satellite under international law: conclusions

303. To sum up, there are no provisions in general international law, including space law, that would entail a prohibition for an international governmental organization such as ISMA to carry out monitoring activities by satellite.

## II. Legal implications of the functions of an ISMA

304. The vital role of reliable verification arrangements for success in disarmament efforts cannot be overstated. During the past two decades, verification has probably represented one of the most serious obstacles to progress in negotiations of disarmament and arms limitation agreements. Solutions to that problem have differed from agreement to agreement, depending upon the nature and the scope of obligations contained therein.

305. The Final Document of the Tenth (the Disarmament) Special Session of the General Assembly 5/ had this to say on the question of verification: "Disarmament and arms limitation agreements should provide for adequate measures of verification satisfactory to all parties concerned in order to create the necessary confidence and ensure that they are being observed by all parties. The form and modalities of the verification to be provided for in any specific agreement depend upon and should be determined by the purposes, scope and nature of the agreement. Agreements should provide for the participation of parties directly or through the United Nations system in the verification process. Where appropriate, a combination of several methods of verification as well as other compliance procedures should be employed."

306. The verification of disarmament and arms limitation agreements serves several purposes. First, verification helps to detect violations of an agreement; second, by increasing the risk of detection, it acts as a deterrent to violations; third, by providing evidence that an agreement is in fact being complied with, it enhances mutual confidence among the parties and creates conditions conducive to further advances in the disarmament process.

307. A number of disarmament proposals have failed to attract support because they lacked adequate monitoring provisions that would afford acceptable risks to the participants. On the other hand, the conclusion of certain arms limitation treaties has been significantly facilitated due to the fact that modern earth observation technology including devices operating from outer space, provides the contracting parties with an effective instrument of monitoring mutual compliance. The SALT agreements concluded between the United States and the Soviet Union are an illustration of such treaties. Adequate verification has been a major issue in connection with the conclusion and ratification of the SALT I and II Agreements. Both have been largely shaped by verification considerations. Parties to these agreements rely for

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4/ United Nations Documents A/35/20, A/AC.105/267 and 271.

5/ United Nations Document A/RES/S-10/2, 13 July 1978, hereinafter referred to as Final Document.

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verification on "national technical means", which is a general term encompassing a variety of technical collection methods for monitoring compliance and, in the context of SALT arrangements, include, in addition to reconnaissance satellites, ships, aircraft, radar ground stations and other technical devices. As regards verification of the SALT Agreements - which includes verification from space - the Parties have agreed to refrain from using concealment measures which would impede verification by national technical means of compliance with the Agreements. Furthermore, the Parties have undertaken not to interfere with each other's means of verification.

(A) Monitoring compliance with existing international arms regulation and disarmament agreements

308. The Group of Experts was aware that certain arms regulation and disarmament agreements at present in force might need to be modified or amended in order to provide for an ISMA's participation in their verification procedures. The findings included in this report do not purport, however, to be more than an educated opinion; a more conclusive evaluation would require major research in treaty interpretation which is beyond the scope of the report.

309. Existing bilateral and multilateral arms regulation and disarmament agreements, as well as the agreements currently under negotiation, may be divided, according to the verification measures provided for therein, into three categories: 1. agreements which contain no verification provisions; 2. agreements which provide for international verification measures; 3. agreements which only refer to "national technical means" for verification; and 4. agreements which combine the characteristics of categories 2. and 3. The purpose of the following survey is to examine the verification provisions in all the multilateral arms regulation and disarmament agreements and on that basis indicate the potential scope of an ISMA's monitoring functions for each agreement, bearing in mind the tentative nature of these findings. (Verification clauses of existing agreements are contained in Annex V).

(a) Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare 6/

310. The "Geneva Protocol" signed at Geneva on 17 June 1925, entered into force on on 8 February 1928. States Parties to the Protocol have not only agreed to prohibit the use in war of such weapons but have also declared that these prohibitions "shall be universally accepted as a part of international law, binding alike the conscience and the practice of nations." The extremely short text of this agreement makes no reference to verification. To the extent that monitoring by satellite compliance with the Geneva Protocol is technically feasible and it is accepted that, even when they contain no verification provisions, disarmament or arms control agreements can still be monitored by national technical means, the document does allow for a role in the verification process by an agency such as ISMA.

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6/ Treaty No. 2138, League of Nations Treaty Series, Vol. XCIV, Nos. 1, 2, 3 and 4, p. 67, 1929.

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(b) Antarctic Treaty 7/

311. The treaty signed on 1 December 1959, entered into force on 23 June 1961. The principal purpose of this Treaty, concluded by the 12 countries 8/ participating in the International Geophysical Year in Antarctica, is to ensure that "Antarctica shall continue forever to be used exclusively for peaceful purposes". The Treaty was not intended to resolve various territorial claims over portions of the continent but rather to provide for free access to all the areas of Antarctica for purposes of scientific research.

312. The Treaty applies to the area south of 60 degrees south latitude, without prejudicing, or in any way affecting, "the rights, or the exercise of the rights, of any State under international law with regard to the high seas within that area" (Article VI).

313. The effect of the Treaty is not only the internationalization of Antarctica but also its demilitarization. Article I (1) of the Treaty prohibits, inter alia, "any measure of a military nature, such as the establishment of military bases and fortifications, the carrying out of military manoeuvres, as well as the testing of any type of weapons." This clearly covers the introduction and testing of nuclear weapons. However, the use of military personnel or equipment for scientific research and other peaceful purposes is permitted under the Treaty (Article I (2)).

314. Article V of the Treaty prohibits any nuclear explosions and the disposal of radioactive waste in Antarctica. The Treaty, however, does not rule out indefinitely the possibility of conducting nuclear explosions for peaceful purposes on the continent. Article V (2) stipulates that the rules establised under international agreements concerning the use of nuclear energy, including nuclear explosions and the disposal of radioactive wastes, would be applied to Antarctica, provided that all the original contracting parties and those other parties which conduct substantial research activities in the continent (the "consultative parties" 9/) are also parties to such agreement or agreements.

315. The Antarctic Treaty provides for an extensive system of inspection based on national means of verification (Article VII). Such inspections are carried out by observers designated by each consultative party who are under the exclusive jurisdiction of the parties of which they are nationals. So far Argentina, Australia, New Zealand, the Soviet Union, the United Kingdom and the United States have exercised the right of inspection.

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7/ Treaty No. I: 5778, United Nations Treaty Series, Vol. 402, p. 71, 1961.

8/ Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the United Kingdom, the Soviet Union and the United States. These "original signatories" are named in the Preamble to the Treaty.

9/ While 19 States are parties to the Antarctic Treaty, only 13 are "consultative parties". These are the 12 original signatories and Poland, whose consultative status was recognized in 1977.

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316. The designated observers enjoy under Article VII "a complete freedom of access at any time to any and all areas of Antarctica," including "all stations, installations and equipment within those areas, and all ships and aircraft" at points of discharge and embarkation in the continent. The consultative parties are also authorised to carry out aerial observation at any time, over any or all areas of Antarctica.

317. By prohibiting the establishment of military bases, the conduct of military manoeuvres and the testing of weapons over a vast demilitarized region, the Antarctic Treaty appears to suit well the proposed functions of ISMA. Before an ISMA can begin verification activities in respect of Antarctica, some legal obstacles may have to be overcome.

318. Article VII, IX and XII of the Treaty are of particular relevance to the possible participation of ISMA in the Antarctic verification process. Under paragraph 1 of Article VII, inspection activities designed to ensure the observance of the provisions of the Treaty may be carried out only by "Nationals of the Contracting Parties which designate them". The right to designate observers is limited to the consultative parties.

319. Under Article IX, the consultative parties are expected to hold regular meetings 10/ to develop and recommend to their governments measures in furtherance of the principles and objectives of the Treaty. Such recommendations specifically include measures regarding both the "use of Antarctica for peaceful purposes only" and the "facilitation of the exercise of the rights of inspection provided for in Article VII of the Treaty". Even if, as a means of implementing these measures, one or more contracting parties would propose a role for an ISMA, according to paragraph 4 of Article IX such measures become effective only "when approved by all" the consultative parties. Thus the requirement of unanimity when joint measures are involved could conceivably delay, perhaps even prevent, the introduction of an ISMA to the Antarctic monitoring system, unless the approval of all 13 consultative parties is first obtained.

320. The amending procedures in the Treaty are also based on the principles of unanimity. According to Article XII (1) (a), the "Treaty may be modified or amended at any time by unanimous agreement" of the consultative parties. Moreover, any such modification or amendment would enter into force only when ratified by all such parties. However, satellite verification may be considered as a "national means" for access referred to in Article VII (see para. 355 below).

### (c) Treaty banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water 11/

321. The "Partial Test Ban Treaty" signed on 5 August 1963; entered into force on 10 October 1963. The parties to the Partial Test Ban Treaty have undertaken "not to carry out any nuclear weapon test explosion, or any other nuclear explosion", in the

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10/ Meetings of the "consultative parties" have been held at approximately two-year intervals since the Treaty entered into force. The most recent such meeting - the 10th - was held in Washington, D.C., 17 September - 5 October 1979.

11/ Treaty No. I: 6964, United Nations Treaty Series, Vol. 480, p.43, 1963.

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atmosphere, under water, or in outer space, or in any other environment if the explosion would cause radioactive debris to spread beyond the borders of the State conducting the explosion. The phrase "any other nuclear explosion" is understood by the parties to include explosions for peaceful purposes.

322. Although originally concluded as a tripartite agreement (between the United Kingdom, the Soviet Union and the United States), the Partial Test Ban Treaty is open to all States and over one hundred nations are now parties to it. The Treaty contains no verification provisions, the original parties having implicitly agreed to monitor compliance by their national means only.

323. Since many States parties to this Treaty do not possess technical means capable of detecting prohibited nuclear explosions, if it is agreed that States may employ the Agency as if it was their own national technical means of verification (see para. 355 below) and in the absence of any clear provisions to the contrary in the Treaty, any contracting party ought to be able if it so wishes, to call on the Agency to verify implementation. The introduction of ISMA in the verification process could be effected without amending or modifying the Treaty.

### (d) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies 12/

324. The Treaty signed on 27 January 1967, entered into force on 10 October 1967. Although it is assumed that an ISMA's monitoring functions would be intended to cover the terrestial environment (i.e. land, sea and the airspace), for purposes of completeness, and as a potential future field of the Agency's operations (in Phase III), outer space,the moon and other celestial bodies, are included in this survey.

325. The Treaty prohibits placing in outer space any objects carrying nuclear weapons or any weapons of mass destruction. The Treaty further bans all military activity on the moon and other celestial bodies, including the "establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres", but excepts the use of military personnel in scientific research and for other peaceful purposes (Article IV). "In order to promote international co-operation" in the use of outer space, the contracting parties have agreed to "consider" requests by other parties for observation of the "flight of space objects launched by them" (Article X). Despite its ambiguity, this provision can be interpreted as providing for "on-site" observation, subject, however, to the consent of the launching State.

326. In Article XII the Treaty provides for inspection, on a basis of reciprocity, by representatives of the contracting parties of all stations, installations, equipment and spacecraft on the moon and other celestial bodies. If such inspection is to be carried out by an on-site visit "reasonable advance notice of a projected visit [must be given], in order that appropriate consultations may be held".

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12/ Treaty No. I: 8843, United Nations Treaty Series, Vol. 610, p.206, 1967.

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327. Notwithstanding the fact that it is for States parties to the Outer Space Treaty to verify its implementation by their own efforts it ought to be possible, providing the monitoring is technically feasible, for any party which so wishes to call on the Agency as a national technical means to verify compliance with the Treaty. (See para. 335 below).

### (e) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies

328. The agreement adopted by the General Assembly on 5 December 1979 13/ is not yet in force. Elaborating upon the corresponding provisions of the Outer Space Treaty, this Agreement effectively demilitarizes the moon and other celestial bodies. It explicitly prohibits the placing of nuclear weapons and other weapons of mass destruction on the moon, orbits around, and trajectories to it (Article 3.3) and bans the use of the moon in order to commit hostile acts or to threaten any such acts "in relation to the earth, the moon, spacecraft, the personnel of spacecraft or man-made space objects" (Article 3.2).

329. Each party to the Agreement is allowed to carry out inspections of all space vehicles, equipment, facilities, stations and installations belonging to any other party, subject to reasonable advance notice. In a significant innovation of particular interest to an ISMA, the Agreement authorises every contracting State to conduct such inspections "on its own behalf or with the full or partial assistance of any other State Party or *through appropriate international procedures* within the framework of the United Nations and in accordance with the Charter" (Article 15.1; emphasis added). Reference to the "appropriate international procedures", it is safe to assume, would cover verification by an ISMA.

### (f) Treaty for the Prohibition of Nuclear Weapons in Latin America with additional Protocols I and II 14/

330. The "Treaty of Tlatelolco", signed on 14 February 1967, entered into force on 22 April 1968. This Treaty, often referred to as the "Treaty of Tlatelolco", is the only international agreement concluded so far which established a nuclear-weapon-free zone in a densely populated area. The Treaty is also the first agreement on arms limitation to establish an effective international system of control under a permanent supervisory organ (Agency for the Prohibition of Nuclear Weapons in Latin America (OPANAL)). The Treaty has two Additional Protocols dealing with matters that concern non-Latin American countries. Protocol I provides for the extension of the nuclear-weapon-free status to certain territories in the zone of application of the Treaty which are under the jurisdiction of States outside the zone. Protocol II is an undertaking by nuclear-weapon States to respect the denuclearized status of the zone, not to contribute to acts involving violation of obligations of the parties, and not to use or threaten to use nuclear weapons against the contracting parties.

331. The Treaty, *inter alia*, defines the terms "territory" and "nuclear weapon"; establishes an international agency to ensure compliance with the Treaty, together with a control system which includes the application of International Atomic Energy Agency (IAEA) safeguards to all nuclear activities of the contracting parties,

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13/ General Assembly resolution 34/68, Annex.

14/ Treaty No. I: 9068, United Nations Treaty Series, Vol. 634, p.281, 1968.

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reporting, inspection and observation of peaceful nuclear explosions; provides for co-operation between OPANAL and other international organizations; and prescribes measures in the event of violations of the Treaty.

332. The basic obligations of the Treaty are contained in Article 1, whereby the contracting parties undertake to use exclusively for peaceful purposes the nuclear material and facilities under their jurisdiction and to prohibit in their respective territories (a) the testing, use, manufacture or acquisition of any nuclear weapons, by the parties themselves directly or indirectly; and (b) the receipt, storage, installation or deployment and any form of possession of any nuclear weapon. They also undertake to refrain from authorizing or in any way participating in the testing, use, manufacture, production, possession or control of any nuclear weapon.

333. The right of the contracting parties to use nuclear energy for non-military purposes includes the right to conduct nuclear explosions for peaceful purposes, even when such explosions involve devices similar to those used in nuclear weapons, provided that those explosions are carried out in accordance with the Treaty (Articles 17, 18).

334. Among the most important provisions of the Treaty are those dealing with verification. The key role in verifying compliance by the parties with the obligations of the Treaty is assigned to OPANAL and IAEA. The control system established under the Treaty has the purpose of verifying, inter alia, that devices and facilities intended for peaceful uses of nuclear energy are not used in the testing or manufacture of nuclear weapons; that none of the activities prohibited in Article 1 are carried out by the contracting parties; and that explosions for peaceful purposes are in accordance with the basic aims of the Treaty, especially with Articles 1 and 5.

335. The contracting parties undertake to negotiate agreements with IAEA for application of its safeguards to their peaceful nuclear activities (Article 13). In addition OPANAL and IAEA have the power to carry out "special inspections" (Article 16). Under Article 18, States parties to the Treaty are obliged to notify in advance OPANAL and IAEA of the date of any intended nuclear explosion; the nature of the nuclear device and its source; the place and purpose of the planned explosion; the proposed procedure for observation by OPANAL and IAEA; the expected force of the device and the fullest information on any possible radioactive fallout that may be caused by the explosion.

336. Of special significance to ISMA are the provisions in the Treaty dealing with links between OPANAL and other international agencies. Article 19.2 empowers OPANAL to "enter into relations with any international organization or body, especially any which may be established in the future to supervise disarmament or measures for the control of armaments in any part of the world". The organ competent to authorise the conclusion of an agreement with ISMA is the General Conference of OPANAL, consisting of all the contracting parties (Article 9).

337. The Treaty is not clear as to whether individual contracting parties may for purposes of verification enter into separate bilateral arrangements with an agency such as an ISMA. Although Article 23 of the Treaty seems to allow bilateral arrangements, observation by ISMA effected bilaterally would possibly have to be limited to the territory of the State which has concluded the agreement.

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### (g) Treaty on the Non-Proliferation of Nuclear Weapons (NPT) 15/

338. The Treaty signed on 1 July 1968, entered into force on 5 March 1970. The basic provisions of the Non-Proliferation Treaty (NPT) are designed to prevent the spread of nuclear weapons; provide assurance, through international safeguards, that the peaceful nuclear activities of States that have not already developed nuclear weapons will not be diverted to making such weapons; promote, in accordance with other objectives of the Treaty, the peaceful uses of nuclear energy through co-operation, with the potential benefits of peaceful application of nuclear explosions being made available to non-nuclear-weapen States parties under appropriate international supervision; and express the determination of the parties to pursue negotiations in good faith on comprehensive arms limitation and nuclear disarmament measures.

339. Article I of the Treaty prescribes the obligations of "nuclear-weapon States" which, *inter alia*, undertake (a) not to transfer nuclear weapons or control over nuclear weapons to "any recipient whatsoever" and (b) not to assist non-nuclear weapon States to "manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices". Article II stipulates the obligations of "non-nuclear-weapon States" which, *inter alia*, undertake (a) not to receive the transfer of nuclear weapons or control over them "from any transfer or whatsoever" and (b) not to "manufacture or otherwise acquire nuclear weapons or other nuclear devices".

340. Of particular importance to an ISMA is Article III of NPT, prescribing an international safeguard system. Its provisions require each non-nuclear-weapon State party to the Treaty to conclude a safeguard agreement with IAEA covering all of the State's peaceful nuclear activities. The purpose of this undertaking is to ensure that no nuclear materials which they acquire for peaceful purposes are diverted to military uses. As of 8 July 1980, 69 States parties to the Treaty (out of 113) have concluded such safeguard agreements, which apply to 617 facilities and other locations. 16/ A corps of IAEA's "nuclear inspectors" now makes regular inspections of designated facilities. According to IAEA, there were by the end of 1978 only five non-nuclear-weapon States with significant nuclear programmes that were not covered by Agency safeguards. 17/

341. IAEA has been assigned the central role in monitoring compliance with the undertakings of the parties. It is the only international body specifically authorized by the Treaty to carry out "verification of the fulfilment of ... [the] obligations assumed under" the NPT (Article III (1)). While technically an ISMA could conceivably assist the IAEA through satellite surveillance in the verification of compliance with the NPT (by providing information on unreported facilities (such as reactors), or on nuclear tests or on-site preparations for such a test), 18/ such assistance does not seem legally feasible without special arrangements between an ISMA and IAEA. Unless it could be done by delegation from IAEA, co-operative arrangements allowing for the full participation of an ISMA in the process of verification would most likely require an amendment to the Treaty; this, however, might not be necessary if an ISMA were to enter into a bilateral arrangement with a contracting party independently of IAEA; however, monitoring by an ISMA under such an arrangement would probably have to be confined to the territory of such a contracting party.

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15/ Treaty No. I: 10485, United Nations Treaty Series, Vol. 729, p.161, 1970.

16/ IAEA Press Release No. PR80/15 of 22 July 1980.

17/ The United Nations Disarmament Yearbook, Vol. III: 1978, p.297 (1979).

18/ It was a Soviet satellite that detected a reported testing facility in South Africa in 1977. D. Fischer, International Safeguards 1979, note 3 at p.5. Publication of the International Consultative Group on Nuclear Energy (The Rockefeller Foundation/The Royal Institute of International Affairs (September 1979)). Mr. Fischer is Assistant Director-General of IAEA.

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342. The procedure for amending the NPT is quite demanding. Before an amendment can enter into force, *first*, it "must be approved by a majority of the votes of all the Parties to the Treaty, including the votes of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors" of IAEA and, *second*, when so approved, the amendment "shall enter into force for each Party that deposits its instruments of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties, including the instruments of ratification of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors" of IAEA [Article VIII (2)].

### (h) Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-bed and the Ocean Floor and Subsoil Thereof 19/

343. The Treaty signed on 11 February 1971, entered into force on 18 May 1972. The Treaty prohibits the contracting parties from emplacing nuclear weapons and other weapons of mass destruction, as well as "structures, launching installations or any other facilities specifically designed for storing, testing or using such weapons" on the sea-bed and ocean floor beyond a 12-mile coastal zone (Article I (1)). In addition to this principal prohibition, the parties undertake not to assist any State in carrying out the prohibited activities nor to participate in such activities in any other way. It should be noted that submarines armed with nuclear warheads are not covered by this Treaty.

344. The verification procedures are set forth in Article III. The contracting parties may conduct verification using their own means, with the assistance of other parties, or through appropriate international procedures within the framework of the United Nations and in accordance with its Charter. Although available information tends to indicate that at this time surveillance from space could not detect violations of the Treaty, ISMA could from a legal point of view qualify as an international agency "within the framework of the United Nations", competent to carry out on behalf of individual States verification of the Treaty.

### (i) Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction 20/

345. The Convention signed on 10 April 1972, entered into force on 26 March 1975. This Convention is the first international agreement since World War II to require States actually to eliminate an entire category of weapons from their arsenals. It significantly expands the prohibitions against biological weapons contained in the Geneva Protocol of 1925 (see paragraph 310 above). Each party to the Convention undertakes "never in any circumstances" to develop, produce, stockpile, or otherwise acquire or retain biological agents or toxins "of the types and in quantities that have no justification for prophylactic, protective or other peaceful purposes", as well as weapons and means of delivery (Article I). All such materials had to be destroyed not later than nine months after the entry into force of the Convention.

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19/ General Assembly resolution 2660 (XXV); Annex, 1970.

20/ General Assembly resolution 2826 (XXVI); Annex, 1971.

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346. There are no provisions in this Convention concerning verification, in the sense in which that term is generally understood. Instead, the contracting parties undertake to consult one another and to co-operate in solving any problems that may arise in the implementation of the Convention (Article V). When a party discovers that a breach of obligations has occurred, it may lodge a complaint with the Security Council of the United Nations. If the Security Council finds that a party has been endangered by a violation, other parties undertake to provide any assistance requested.

347. If certain violations of this Convention are detectable from outer space, the monitoring services of an ISMA could be employed by decision of the Security Council to assist its investigation of a specific complaint in accordance with Article 34 of the Charter. In these circumstances, participation of an ISMA in the verification process would probably not require an amendment of the Convention.

### (J) Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques (ENMOD Convention). 21/

348. The Convention signed on 18 May 1977, entered into force on 5 October 1978. The Convention defines "environmental modification techniques" as activities capable of changing - through the deliberate manipulation of natural processes - the dynamics, composition or structure of the earth (including its biota, lithosphere, hydrosphere and atmosphere) or of outer space (Article II). Parties to the Convention undertake "not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party" (Article I (1)). The use of environmental modification techniques for peaceful purposes is explicitly permitted by the Convention, provided that such use does not contravene "generally recognized principles and applicable rules of international law" (Article III (1)).

349. Like the Biological Weapons Convention (see paragraphs 345-347 above), this agreement contains no specific provisions on verification. It provides, instead, for mutual consultation among the parties and for their co-operation "in solving any problems that might arise" in the application of the Convention. The parties are allowed to seek such consultations and co-operation also through "appropriate international procedures within the framework of the United Nations", including the "services of appropriate international organizations" as well as of a "Consultative Committee of Experts" established by the Convention (Article V (1) (2)). These services could therefore include those of an ISMA. Complaints alleging breach of obligations undertaken by the parties in accordance with Article V may be lodged with the Security Council of the United Nations. The Security Council, in turn, may initiate appropriate investigation of the charges. In carrying out this funct function, the Council could consider the use of an ISMA.

### (B) Monitoring compliance with future international arms regulations and disarmament agreements

350. Member States of the United Nations are presently engaged in discussing a number of arms regulation measures, including agreements on a comprehensive test ban, chemical and radiological weapons, as well as proposals for new nuclear-weapon-free zones and for arrangements to protect non-nuclear-weapon States against the use or threat of use of nuclear weapons. Whereas verification is of importance to all of these agreements effective verification procedures will be critical for the conclusion of some of them. For this reason and because of their intended global application,

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21/ General Assembly resolution 31/72; Annex, 1976.

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these agreements evidently are of potential interest to an ISMA. Since none of the above-mentioned arms control proposals is yet available in an agreed draft-treaty form, it would be difficult to suggest a specific role for an ISMA in their monitoring. However, a tentative suggestion applicable to at least some of these future accords could be offered: ideally, if technically feasible, these agreements would incorporate explicit reference to an ISMA as an instrument for verification of compliance; should that prove acceptable, the negotiating parties could urge that provision for a role in the verification process by appropriate international organizations, such as an ISMA, be included in the agreements which are suitable to monitoring by satellite. A brief outline of the subject-matter of each of these proposed agreements is presented below.

351. Comprehensive Test Ban Treaty. The question of the cessation of nuclear weapon tests in all environments has been the subject of discussions and negotiations within the United Nations organs and without for a long time. The USSR, the United Kingdom and the United States continue to hold tripartite negotiations with a view to reaching agreement on a treaty prohibiting such tests and on a protocol covering nuclear explosions for peaceful purposes. So far these efforts have failed to produce agreement. The most critical aspect in the negotiation of a comprehensive test ban and the principal reason given for lack of progress to date is the problem of verification. It is worth noting that, as part of the verification procedures the Committee on Disarmament *Ad Hoc* Group of Experts has recommended that the treaty provide for the establishment of a global network of seismological stations for the international exchange of relevant data. Although observation from space alone probably could not detect minor underground tests, monitoring by ISMA, together with seismic and other to be agreed means of verification might provide a useful service.

352. Prohibition of chemical weapons. The contemplated convention on chemical warfare, being negotiated by the Committee on Disarmament would prohibit the development, production and stockpiling of chemical weapons and require destruction of existing stockpiles. One of the most controversial aspects in these negotiations is that of verification. The difficulty in devising adequate verification methods, particularly in regard to non-production of chemical weapons and to destruction of stockpiles, continues to present a major obstacle to agreement; it also illustrates the crucial role of verification for certain disarmament accords. While the two initial negotiating parties - the USSR and the United States - seem to agree that verification could be based on a combination of national means and international controls, they have so far failed to reach a common understanding on the role of international organs. Other unresolved questions concern the procedure for initiating specific verification measures and for monitoring compliance. An ISMA might be able to make a contribution in this connection as indicated in paragraphs 137 to 139 and paragraph 161 of Chapter I.

353. Convention prohibiting radiological weapons. The question of banning radiological weapons has been on the agenda of the United Nations since 1969, although never as one of the main topics of discussion. The weapons under consideration cover devices containing radioactive substances which would be dispersed over the

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target areas independently of nuclear explosions. The Final Document gave new impetus to the idea of outlawing these weapons by urging in paragraph 76 that "A convention should be concluded prohibiting the development, production, stockpiling and the use of radiological weapons". However, no such devices seem to exist today and the proposed agreement does not cover atomic, hydrogen or neutron weapons. Negotiations on a radiological weapons convention have been largely held on a bilateral basis, between the Soviet Union and the United States. In 1979 they submitted the text of an agreed joint proposal on major elements of a convention to the Committee on Disarmament where it is currently under examination. In 1980 the Committee on Disarmament established "an Ad Hoc Working Group with a view to reaching agreement on a convention prohibting the development, production, stockpiling and use of radiological weapons." 22/

354. Nuclear-weapon-free zones. Proposals for the denuclearization of Africa and for the establishment of a nuclear-weapon-free zone in the Middle East and South Asia have been dealt with in several General Assembly resolutions and enjoy wide support among the States of those regions. According to the Final Document (paragraphs 60, 61, 62), the setting up of such zones would not only enhance international peace and security but also constitute an important disarmament measure. On the assumption that future denuclearization agreements would likely be patterned after the Treaty of Tlatelolco, one can visualize a role for ISMA in their verification process comparable to that which it might play in Latin America as described in paragraphs 147 to 150 and 330 to 337 above.

## (C) The use of ISMA as a "National Technical Means"

355. Assuming that States can use their national technical means to monitor existing agreements to which they are parties, the question arises if recourse to ISMA could be made as if the monitoring activities carried out by the Agency were performed by that State. If this approach is adopted, it would not be necessary to modify existing agreements for the purposes of using ISMA for their verification. Accordingly, a provision could be considered in the constitutive act of an ISMA which could enable its members to take recourse to the Agency as if it were their own national technical means of verifying compliance with Agreements to which they are parties.

## (D) Monitoring bilateral regional and other accords

356. In addition to its potential role in the monitoring of the existing multilateral arms regulation agreements and those currently under negotiation, ISMA could also provide a useful service in monitoring compliance with bilateral and regional arms control and disarmament agreements, as well as with other relevant bilateral and regional accords. There is no legal reason why two or more States willing to conclude such an agreement could not designate ISMA as one of the instruments of verification. In this connection, it is pertinent to note that the Statute of the IAEA in Article III.A.5 authorizes the Agency to "apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy". Pursuant to this authorization, the IAEA has entered into numerous bilateral agreements with States members of the Agency. Observation by satellite could provide useful supportive information to the contracting parties on, for example, large strategic weapons, military construction, test ranges, ship and submarine buildings, major concentration of troops, and generally on an unusual event suggesting the possibility of a preparation for armed attack. Combined with other sources of

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22/ Document CD/79 of 17 March 1980.

information, monitoring from space by an international agency could result in an effective system of verification that would, in addition, contribute to confidence building between the States involved.

### (E) Monitoring of international crises

357. The establishment of an ISMA would represent a potentially significant step towards developing a climate of international confidence, a prerequisite for any meaningful disarmament measure. If given a chance, this initiative might contribute substantially, in the more distant future, to the realization of the perennial goal of the United Nations - "general and complete disarmament under effective international control".

358. The Group of Experts reached the conclusion that monitoring by satellite of international crisis situations is technically feasible and that ISMA could make an effective contribution in the observation from space of military aspects related to the inception and development of conflicts. (See paragraphs 166 to 173 of Chapter I). The type of monitoring envisaged would include verification of compliance with cease-fire arrangements; surveillance of demilitarized zones; provision of evidence of border violations or preparations for aggression; and any other mission which States or the United Nations may assign to the Agency that would be consisten with its constitution.

359. The legal régime governing crisis monitoring by satellite is no different from that applicable to monitoring of disarmament agreements, described above. The Group of Experts agreed that the Security Council could legally request ISMA services for the monitoring of a particular crisis situation pursuant to its investigative powers under Article 34 23/ of the Charter. Similarly, since the General Assembly also has the power to engage in fact-finding, an ISMA if requested, could assist that body in its investigations. What other situations the Agency may or may not monitor will, of course, have to be determined by States themselves.

360. Clearly, therefore, the need for crisis monitoring will continue to grow. It will be necessary for the United Nations to have at its disposal the most advanced technology, in particular, space technology, to enable it to perform, in the best possible conditions, its function of maintaining international peace and security. In this context, ISMA would not fail to make a positive contribution.

## III. Specific legal issues relating to the establishment and functioning of an ISMA

361. This part of the Report focuses on the fundamental principles underlying an ISMA as an organization of Member States of the United Nations concerned with finding more effective ways of maintaining and promoting the goals of international peace and security; explores various options available for establishing the Agency and for bringing it into an effective relationship with the United Nations system; and suggests the nature of the legal instrument by which such an agency should be constituted.

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23/ According to Article 34 of the Charter of the United Nations "The Security Council may investigate any dispute, or any situation which might lead to international friction or give rise to a dispute, in order to determine whether the continuance of the dispute or situation is likely to endanger the maintenance of international peace and security."

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### (A) Fundamental principles of an ISMA

362. As an intergovernmental organization designed to advance the cause of peace and international security an ISMA should carry out its tasks in accordance with international law, including the United Nations Charter, the outer space treaty and any other relevant international agreements.

363. ISMA should be founded on, and shall be guided in its activities by, the principle of sovereign equality of all its members. In accordance with this principle, all member States of an ISMA should have equal rights in the formulation of an implementation of the Agency's policies. In the exercise of its functions, ISMA will respect the sovereign rights of all States, in accordance with the provisions of its constitution.

364. The ultimate goal of an ISMA, as well as one of its guiding principles, should be universality of membership. This reflects a recognition of the fact that all nations have a vital interest in controlling and eventually eliminating the arms race and other threats to peace. At the same time, they share a responsibility, as members of the world community, to actively participate in the processes aimed at maintaining and strengthening international security. As the General Assembly resolution concerning a World Disarmament Conference pointedly notes, "all peoples of the world have a vital interest in the success of disarmament negotiations and ... all States should be in a position to contribute to the adoption of measures for the achievement of this goal". 24/ Therefore, membership in ISMA would be open to all States Members of the United Nations and its specialized agencies.

### (B) Legal status of an ISMA

#### (a) Legal nature of an ISMA

365. One of the most important questions which Governments interested in the establishment of an ISMA will have to resolve is that of the legal nature of the Agency and the links between it and the United Nations. It was recognised that the function of an ISMA could be part of a general disarmament or verification organization and under the auspices of the United Nations the different options for affiliation discussed below could also apply to such an organization; in any way the review of these options should not be regarded as excluding the possibility that satellite monitoring could be part of an organization with a larger mandate, if this were the wish of the world community.

##### (i) ISMA as a specialised or other related agency of the United Nations

366. Decentralization is one of the main characteristics of the United Nations system of intergovernmental organizations. Within that system, each agency is responsible for a distinct field of activity, has its own membership, secretariat, as well as legislative and executive bodies; each prepares its own budget and enjoys a considerable degree of autonomy. They all work with the United Nations and each other through the co-ordinating machinery of the United Nations Economic and Social Council (ECOSOC), to which they report annually, under Article 64 of the Charter.

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24/ United Nations document A/RES/34/81, 3 January 1980.

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367. Article 57 of the United Nations Charter provides that the "various specialized agencies, established by intergovernmental agreement and having wide international responsibilities, as defined in their basic instruments, in economic, social, cultural, educational, health and related fields, shall be brought into relationship with the United Nations". The establishment of this relationship is effected by agreement between the United Nations and the individual specialized agency. At the end of 1979, "relationship agreements" between the United Nations and 15 specialized agencies were in force.

368. These agreements generally follow a standard pattern. They provide, inter alia, for the recognition of the status of the organization as a "specialized agency"; reciprocal representation at meetings; exchange of information; reciprocal inclusion of agenda items when requested; annual reports by the agencies to the United Nations; transmission of the budgets of the agencies for the consideration (but not the approval) of the General Assembly; the right of the agency to request an advisory opinion from the International Court of Justice; and assistance by the agency to the Security Council and, in some cases, other principal organs of the United Nations. Each specialized agency has also agreed to consider any recommendations made to it by the United Nations and to report to the Organization on the action taken pursuant to any such recommendation. The agreements between the United Nations and its specialized agencies have not significantly increased the supervisory role of the United Nations over the agencies or diminished their autonomy.

369. Although formally not a "specialized agency", IAEA is practically treated as one within the United Nations system. Because the Agency has sensitive political and security responsibilities, which could not properly be dealt with by ECOSOC, IAEA concluded its relationship agreement with the General Assembly. Its regular reports are submitted directly to that body. Over some aspects of IAEA's activities the Security Council also exercises a supervisory role.

(ii) ISMA as a subsidiary organ of the General Assembly

370. The General Assembly has the authority under Article 22 of the Charter to establish "such subsidiary organs as it deems necessary for the performance of its functions". It has so far established, mainly by resolution, a large number of subsidiary organs, with very diverse functions and membership, and of differing duration. As far as their function is concerned, these subsidiary organs include study institutions, such as the United Nations Institute for Training and Research (UNITAR), bodies with political responsibilities, such as the United Nations Council on Namibia, "judicial" organs, such as the United Nations Administrative Tribunal, and humanitarian organs, such as the United Nations Relief and Works Agency for Palestinian Refugees in the Near East (UNRWA). Certain subsidiary organs established by the General Assembly enjoy a large degree of autonomy, especially UNITAR, the United Nations Conference on Trade and Development (UNCTAD) and the United Nations Industrial Development Organization (UNIDO); 25/ Some of these organizations, for example, UNCTAD and UNIDO, share the characteristics both of subsidiary organs and specialized agencies.

371. In view of the envisaged functions of an ISMA, the Group noted that the allocation of competence between the General Assembly and the Security Council on matters involving "international peace and security" would have to be taken into consideration.

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25/ Following the adoption of its constitution, on 8 April 1979, UNIDO is to be converted into a specialized agency.

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### (iii) ISMA as a subsidiary organ of the Security Council

372. Article 29 of the Charter authorises the Security Council to "establish such subsidiary organs as it deems necessary for the performance of its functions". The possibility of setting up ISMA as a subsidiary organ of the Council was also entertained by the Group. One advantage of this method of linking ISMA with the Security Council, it was pointed out, would be that the chances for participation of the space powers in the Agency's work would be improved. This advantage, however, would be counter-balanced by the need to obtain the unanimity of all the permanent members of the Council. It was recognised that while ISMA should always be ready to respond, in accordance with its constitution, to a call by the Security Council for assistance, it should not become a subsidiary organ of the Council or be placed under its jurisdiction.

### (iv) ISMA as an independent organisation

373. Consideration was also given to the possibility of establishing an ISMA as an independent organisation outside the United Nations system. However, since this option found no support in the Group, it was not explored any further.

### (v) Legal nature of an ISMA: Conclusion

374. Having examined the above options, the consensus was that the Agency should be an independent body, closely linked with the United Nations, as it is only through a close relationship with the United Nations that an ISMA will be able to attract to its membership a large number of States and enjoy the full trust of the international community. Since an ISMA's functions involve matters beyond the scope of ECOSOC, it was felt that the Agency's link with the United Nations should be established through the General Assembly rather than through ECOSOC as is the case with the specialized agencies.

### (b) Nature of the Constitutive Act

375. All the major international intergovernmental organizations, including existing specialised agencies, came into being by means of a treaty or convention. The legal instrument creating an ISMA and stipulating its functions and powers must be of the same kind. Considering that an ISMA would be an operating agency with a highly sensitive mission, affecting the security interests of States, its establishment through any less formal legal instrument would be inappropriate. The detailed provisions covering various organisational, financial and personnel questions could be included in one or more annexes to the basic treaty.

### (c) Legal personality

376. It is axiomatic that ISMA could not carry out its functions in the fields of disarmament and international security, without entering into binding legal arrangements with States and other international organisations. In order to be able to do so, the Agency must be endowed with "international legal personality". Possession of such international personality would give an ISMA the right under international law, *inter alia*, to conclude treaties, enjoy in the territory of its member States for itself and its officials various privileges and immunities, including inviolability of premises and archives, as well as freedom of communications (e.g. the right to use codes and 'diplomatic' couriers and bags).

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377. All specialized agencies of the United Nations and a majority of organizations established by a multilateral intergovernmental agreement have been accorded an international legal personality, though not necessarily of the same scope. Customarily, the constitutive instrument of each such organization contains provisions in regard to its legal personality. These instruments spell out with varying degrees of explicitness the attributes of the organization's legal personality. For example, the Statute of IAEA prescribes in Article XV-A): "The Agency shall enjoy in the territory of each member such legal capacity and such privileges and immunities as are necessary for the exercise of its functions". The details concerning legal capacity of IAEA in the territory of its member States are defined in a separate agreement between the Agency and each member State [Article XV-C)]. Article 25 of the Convention on the International Maritime Satellite Organization (INMARSAT) is more explicit: "The Organization shall have legal personality and shall be responsible for its acts and obligations. For the purpose of its proper functioning, it shall, in particular, have the capacity to contact, to acquire, lease, hold and dispose of movable and immovable property, to be a party to legal proceedings and to conclude agreements with States or international organizations". The Convention for the Establishment of a European Space Agency provides simply that "The Agency shall have legal personality"; the details of the Agency's prerogatives are left to Annex I to the Convention. The most recent formulation concerning the grant of legal personality to an international organization of interest to an ISMA can be found in the Statute of the Seabed Enterprise (Annex IV to the draft Convention on the Law of the Sea). According to Article 13 (2), "The Enterprise shall have such legal capacity as is necessary for the performance of its functions and the fulfilment of its purpose and, in particular, the capacity: (a) to enter into contracts, forms of association, or other arrangements, including agreements with States and international organizations; (b) to acquire, lease, hold and dispose of immovable and movable property; (c) or be a party to legal proceedings in its own name.

## IV. Legal implications of ISMA's activities

### (A) Acquisition, use and dissemination by ISMA of data and/or information

#### (a) Definition of the terms "data" and "information"

378. Since the substance of an ISMA's work would be the collection and dissemination of data and information, the definition of these terms would have an important bearing on the work of the Agency. The complexity of the task and the significance attached to it by States is reflected in the lengthy debates which preceded the adoption in 1978 of a tentative definition of these terms, and its later refinements in the legal sub-committee of the COPUOS. 26/

379. Taking into account that the technical development may make it possible in the future to transmit from satellites not only "raw" (primary) data to the Earth, but also partly analysed imagery data the Group concluded that a more complete definition of the terms "data" and "information" would have to be discussed when an ISMA was to be established. For the purpose of this report the Group used the following understanding of these terms:

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26/ United Nations document A/AC.105/271.

- the term "data" refers to "raw" (primary) imagery data, either photographic or digital, obtained by satellites;
- the term "information" refers to information obtained by analysing raw/primary satellite data.

For this analysis and owing to the limitation of space systems, data acquired by satellites would, particularly for monitoring crisis situations have to be supplemented by data and information from other sources, e.g. about weapons and weapons systems, major stationary military objects, as well as geographical, seismological, topographical and oceanographic details and conditions. Such data, "auxiliary data", would be stored in a "data bank" of the Agency and could be acquired from open sources or supplied by member States. In addition, especially for Phase III, an ISMA would need meteorological data and information from different regions of the globe.

(b) Existing practices relating to acquisition and dissemination of data/information

380. The practice of States, in regard to the acquisition and dissemination of data and information gathered by satellite, has already been dealt with in this report (see paragraphs 290 and 300 to 302 above). Data and information of military significance collected by satellites belonging to space powers, as a rule, are not available to the public; the State carrying out the surveillance decides unilaterally what kind of data/information to release, and to whom, when and in what form. By contrast, civilian data from remote sensing satellites are freely disseminated or disseminated with some restrictions. Moreover, participation in the Landsat programme is open to all States and many have entered into co-operative agreements with NASA in order to secure a steady flow of data generated by this satellite system. The United States has stated that data and information on natural resources and the environment of the earth, obtained by its civilian satellite-borne sensors, must continue to be made publicly available. Furthermore, the USSR informed the Outer Space Committee that it was prepared to supply remote-sensing data to countries which might wish to purchase them. The USSR specified however that (photographic) data with a "better than 50 metres resolution on terrain" would be made available only with the consent of those countries whose territory was covered by that data.

381. Global dissemination of meteorological data/information gathered by satellites and other means of observation takes place today through the World Weather Watch (WWW) programme, organised and co-ordinated by the World Meteorological Organization (WMO). Established in 1963, for the purpose of achieving a comprehensive, integrated, global coverage, WWW is the most important current activity of WMO. It consists of a world-wide network of stations, ships, aircraft, satellites, and other observing systems, with a space-based subsystem composed of geostationary and polar-orbiting meteorological satellites provided by Japan, United States of America, USSR and the European Space Agency (ESA) and stations providing for the reception of signals from operational satellites. In the near future, India is also expected to contribute to this subsystem through its multipurpose geostationary satellite.. WWW has its own co-ordinated global data processing and global telecommunication systems. The meteorological data gathered is analysed and processed regularly at three World Meteorological Centres (WMC) located in Melbourne, Moscow and Washington, at 25 Regional Meteorological Centres (RMC), and at about 100 National Meteorological Centres (NMC). The products of WMCs and RMCs and observational meteorological data are made available to all NMCs through the WWW Global Telecommunication System (GTS)".

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382. The usefulness of the WMO experience to ISMA, in terms of the acquisition and dissemination of satellite data/information, seems limited. First, data and information transmitted to this organization by the satellite-operating States are of a non-sensitive nature, traditionally freely shared; second, the existence of an integrated world-wide weather reporting system is of immediate and direct benefit to all nations, including the space powers.

(c) Modalities of acquisition of data and/or information

383. As already mentioned, the possible evolution of an ISMA would extend over three phases. In Phase I the Agency would establish an Image Processing and Interpretation Centre (IPIC) which would work on data and information from various sources, obtained from existing satellite systems but would also need auxiliary data and information (see para. 379 above). Such additional data/information could be provided on a voluntary basis by member States or obtained from other authorized sources. Except when relevant materials are acquired free of charge, an ISMA would have to enter into arrangements with the suppliers in order to secure a steady flow of data from existing national systems. For the acquisition of some data and information a simple contract of purchase will be sufficient.

384. In Phase II an ISMA would begin operating its own ground stations for access to national satellite systems. However, before the construction of such stations may begin, the Agency would have to negotiate agreements with the States on whose territory these facilities are to be located. Since it can be expected that ISMA's ground stations would be located on the territory of its member States, it would seem advisable to require member States of the Agency through the constitutive instrument to permit such stations on their territory. The use of radio frequencies for data reception and transmission would have to be discussed in order to avoid interference both for ISMA itself as well as for the host country. If the Agency were to operate with encrypted data (see para. 386 below) this might necessitate a special understanding with the host country.

385. In Phase III ISMA is expected to own and operate its own space system. However, if the co-operation of space powers is not available in Phases I and II, consideration might be given to the direct transition of the Agency from Phase I to Phase III. Since at this stage ISMA would operate satellites, this dimension of its activities would be subject to and regulated by the principles and rules of international law including space law. (See paras. 287 to 299 above). In this phase of its activities, an ISMA would need to secure facilities for the launching of its satellites. 27/ The provision of this service would depend upon the negotiation by an ISMA of contractual arrangements with one of the States possessing these facilities or with an international space-launching organization.

(d) Question of confidentiality of data processing, formating and archiving

386. The handling of primary data obtained from satellites in the Agency could either be open or confidential. The Group discussed arguments for and against the two possibilities but did not consider it the task of the Group to recommend a particular solution to this question. The Group recognized that this aspect would be of great importance for States considering their participation in the establishment of an ISMA.

387. On the one hand, arguments in favour of openness were that any misuse of the Agency could be controlled from the outside and, more important, the end-product

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27/ It is assumed that ISMA will not in the foreseeable future acquire its own launch vehicles.

of the work of the Agency, a factual report, could be scrutinised in a way which would provide a guarantee for an impartial operation of the Agency. The adoption of open working methods should, however, not mean that outsiders would be able to request data in a way that would prevent the Agency from working efficiently. It would rather mean that the material used for the report would be available, at least after the completion of the report. The details for such a working method would have to be subject to provisions in the Constitutive Act of the Agency and possibly to internal regulations.

388. On the other hand, the arguments for confidentiality were that, in view of the sensitive nature of some of the data obtained by the Agency, appropriate measures may have to be considered to safeguard their confidentiality during transmission, processing, analysis and archiving. For instance, though weather satellite and most earth resources satellite data would be handled without restriction, the data required by an ISMA may be considered sensitive by supplier States in Phases I and II and probably by others in Phase III. It was further noted that the required confidentiality may not be assured by legal, technical or administrative constraints, but the constitutive act may, nevertheless, have to provide appropriate provisions in this regard.

### (e) Question of dissemination of data and/or information by an ISMA

389. The question of dissemination of data and/or information by the Agency comprises two aspects: (a) dissemination of raw/primary satellite data received by the Agency and (b) dissemination of the information which is the end-product of the analysis performed by an ISMA on the primary data; this could be the minimum content of the factual report to be presented by the Agency (hereinafter referred to as the ISMA Report). As regards the first aspect - dissemination of raw/primary satellite data from the Agency - it would, *inter alia*, depend on the conditions for access by the Agency to such data and decision as regards handling of data (see paras. 386 and 387 above).

390. An important preliminary question to be decided concerns the form in which an ISMA Report should be released. The mere dissemination of data including auxiliary data, without any interpretation by the Agency, would tend to promote confidence in the accuracy and impartiality of the findings, because no human evaluation would be involved. However, the adoption of this format for the ISMA Reports would produce unintelligible information for those users who do not possess appropriate technology and skills to do their own interpretation. This method would clearly discriminate in favour of the technologically more advanced States. It therefore seems that ISMA's role would be to provide a factual report based on the processing and analysis of the data available to it. The Group also recognized that inconclusive or contradictory interpretation could emerge in the course of analysis of data by teams at the IPIC and was of the view that in such cases a thought might be given to providing the users with more than one analysis together with data used for such analysis.

391. Access to ISMA Data and Reports. While the existing international law contains no specific prohibition against unrestricted dissemination of data and information collected by satellite, regardless of the nature of such data/information, the widely differing views of States on this matter will have to be taken into account in the establishment of ISMA.

392. In regard to the question of who should have access to ISMA Reports, various possibilities can be identified, among them: (a) ISMA Reports to be made available to all Members of the United Nations; (b) only to the members of the Agency; (c) only to the Security Council, the executive organ of the Agency and the States

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directly concerned (e.g. parties to a dispute; parties to a relevant treaty), and (d) only to the States directly concerned and to the executive organ of the Agency. These options are examined below. It should, however, be emphasized that application of each option will also depend upon the relevant provisions of its Constitutive Act.

393. In support of the option under (a) it could be said that since the maintenance of peace and international security is of vital interest to all States, they should all be entitled to receive information gathered by ISMA. This practice of wide dissemination may also increase mutual trust among States and deter a potential aggressor or a party about to violate a disarmament agreement. Furthermore, recent trends in the technology of remote sensing by satellite make it likely that an increasing volume of data in the possession of ISMA may soon be available on the open market. For these reasons, some States can be expected to favour option (a). Against this option could be said that the Agency would be dealing with matters relating to the Security of States. Therefore, some States could be reluctant to join an ISMA or to accept policies of open disclosure. Some might refuse to join the Agency on the ground that they could obtain ISMA Reports at no cost, in contrast to fee-paying member States.

394. The reasons given above in favour of unrestricted dissemination, apply equally to option (b), which provides for dissemination of ISMA Reports only to the member States of the Agency. This option is also in accord with the most fundamental objective of any international organization: a joint enterprise of like-minded States, willing to share responsibilities and burdens, for the achievement of common goals. Nevertheless, this régime too suffers from a certain number of disadvantages identified with respect to option (a).

395. Option (c) would restrict access to information to the Security Council, the parties directly concerned and to the executive organ (the Council) of an ISMA. It would be in keeping both with custom and international law, in this field for every country to be given access to any ISMA report pertaining to its territory. In that connection it may be noted that a tentative agreement on a comparable principle, concerning remote sensing of the Earth from space, has been reached in the Legal Sub-Committee of COPUOS. Finally, it is inevitable that the executive organ of ISMA would be privy to any and all data and information entering the Agency and being disseminated by it. Appropriate provisions to that effect should be incorporated in the constitutive instrument of ISMA. The availability of this report to the 15 States members of the Security Council in addition to the States directly concerned may well lead to its publication.

396. Option (d) provides for the most restrictive régime, limiting dissemination of ISMA Reports to the parties directly concerned. Under this option, wider dissemination of the ISMA Reports is possible whenever the parties directly involved so request. While strict confidentiality of ISMA Reports concerning a specific "crisis situation" could be justified, when a violation of a multilateral disarmament or arms control agreement is discovered by the Agency, strict confidentiality may be more difficult to justify. In such cases the desirability of disseminating the findings to all parties to the agreement in question should at least be considered.

397. Which among the options examined would ultimately be adopted in the Agency's constitutive act is a matter for decision by the negotiators concerned with the establishment of ISMA.

398. Decision-making procedure within an ISMA relating to the dissemination of data and/or information in the possession of the Agency. If the principle of unrestricted dissemination is adopted, the decision-making power could be granted to either the

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executive organ (the Council) of an ISMA or the principal administrative officer of the Agency. If the principle of restricted dissemination is adopted, three options could be considered. Granting the decision-making authority to the plenary organ of ISMA (the Assembly), while democratic in appearance, would obviously be impractical since that body would be in session only periodically (probably less than once a year). On the other hand, it might prove to be unacceptable to a majority of member States to grant such authority to an official of ISMA. It would seem, therefore, that the power of decision in regard to the release of confidential reports prepared by an ISMA would be placed in the hands of the Council. Future negotiations should determine the voting techniques in the Council when it exercised this important function (i.e., whether to adopt the rule of unanimity, or the rule of qualified or simple majority). Among these options, the unanimity rule appears least satisfactory, given the urgency of the subject-matter of voting. The considerations reflected in this paragraph do not preclude States parties to arms control or disarmament agreements from determining for their own purposes the procedure for dissemination of the Agency's reports on the verification of those agreements. However, the provisions so adopted should not do more than supplement or complement the provisions of the constitutive instrument of ISMA governing the dissemination of the latter's report.

### (D) Initiation of ISMA Action

#### (a) Nature of ISMA action

399. Since interpretation of satellite data would need reference to and comparison with satellite data acquired earlier of the areas involved, action by an ISMA may imply near continuous or periodic acquisition and archiving of data. Hence, it was recognized that consideration may have to be given in the Constitutive Act to allow an ISMA to carry out such continuous action.

#### (b) Upon request by a principal organ of the United Nations

400. Since the mission of ISMA is not to act as a general surveillance organ for the world community, it is necessary to identify with precision the conditions under which it will spring into action. Monitoring of international crises being one of its two main functions, the Agency would promptly respond to a request by the Security Council for assistance in the investigation of "any dispute or any situation which might lead to international friction or give rise to a dispute" (Article 34 of the Charter) The participation of an ISMA in a possible fact-finding mission requested by the General Assembly should also be considered. For some years the world organization has been searching for new, more effective, methods in fact-finding as a contribution to the peaceful settlement of disputes; ISMA could provide at least a partial answer to a widely recognized need.

#### (c) Upon request by an intergovernmental organization

401. An ISMA could initiate monitoring activities upon request by any intergovernmental organization, provided the services sought are consistent with the Agency's Constitutive Act. OPANAL and IAEA are two such organizations which might seek an ISMA's assistance for the verification of the Treaty of Tlatelolco (OPANAL) and the Non-Proliferation Treaty (IAEA) (see paras. 336 and 341 above). In particular, ISMA would act upon request by a United Nations disarmament agency, should one be established in the future. Note should also be taken of the possibility of incorporating the functions of an ISMA in such an agency.

#### (d) Upon request by a member of an ISMA

#### (i) Of its own territory

402. Every State could request the Agency to monitor by satellite the whole or part of its national territory in an international crisis affecting that State, in the case of an alleged violation of an international agreement to which that State is a party or

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in other circumstances to be defined in an ISMA's constitutive act. Such a request by a member State addressed to an ISMA would invariably be granted, unless the Agency's facilities were more urgently needed elsewhere. A clause in the Agency's constitution, providing for the possibility of monitoring the member's territory as a condition of membership, should also be considered.

(ii) Of the territory of (an)other State(s)

403. A member State of ISMA might request the monitoring of the territory of another State when it alleges violation of an arms regulation agreement to which both are parties. This would be possible when an arms regulation agreement provides explicitly or by implication for monitoring by ISMA, or if it is accepted that ISMA can be used as a "national technical means". Under what circumstances an ISMA could be requested by a member State to monitor a crisis situation would have to be determined by States themselves.

404. When allegations of non-compliance with an arms regulation agreement are to be monitored, an ISMA would provide its services if requested by a party to such an agreement. The Agency's monitoring activities would be governed by provisions of the agreement in question, it being understood that States are free to decide, in consultation with an ISMA, which provisions they wish to see applied. The competence of an ISMA to report on a specific "crisis situation" upon request of a member State, would derive either from the general grant provided for in its Constitutive Act (where all parties to a dispute are members of an ISMA), or, in the absence of such a grant, from a special agreement with the State(s) directly concerned. Consideration should be given to incorporating in the constitution of ISMA provision enabling the Agency to monitor the territory of member States whenever they are involved in a "crisis situation".

405. It might be advisable for an ISMA to formulate the "standard clauses" of a monitoring agreement, allowing States a number of alternatives on matters such as: (a) the frequency of satellite monitoring of a particular area; (b) the rate and form of dissemination of the results obtained by monitoring; and (c) the modalities of consultation between the Agency and the States involved.

(iii) Of areas not subject to the sovereignty of any State

406. Conceivably, a member State might request ISMA to monitor areas not subject to the sovereignty of any State, such as the high seas and outer space, or areas with a special legal régime. Provided the request is consistent with the Constitutive Act of an ISMA, and its resources permit it, the Agency would initiate monitoring of such areas.

(e) Upon request by non-member State(s)

407. In principle, an ISMA would carry out its missions on behalf of its members and of relevant intergovernmental organizations, entitled by its Constitutive Act to call on its services. However, since the maintenance of international peace and security is of vital concern to all nations, in appropriate circumstances and consistent with its Constitutive Act, ISMA may make its services available also to a non-member State. Thus, as a rule, a non-member could have recourse to ISMA in regard to a "crisis situation" in which no member State is involved, or for the monitoring of the areas not subject to the sovereignty of any State.

(f) Upon request by States parties to an agreement providing for international monitoring

408. The situation could also be envisaged in which an ISMA would be called upon to monitor on a constant basis, the territories of States parties to an international agreement in accordance with the provisions of the agreement.

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## V. Membership and organs of an ISMA

### (A) Membership of an ISMA

409. Three kinds of formal participation in ISMA can be envisaged: regular membership, associate membership and "observer status". Only regular membership entails all the rights, privileges and duties as provided for in the Constitutive Act of an ISMA. The category of "associate" membership exists under the constitutions of several specialized agencies (e.g. WMO, ITU, IMCO), to permit participation by entities which are not States. The institution of "associate" membership in ISMA might be considered as a convenient device for States which wish to closely observe the work of the Agency before applying for regular membership. "Associate" members would have no voting rights and would not be eligible to serve in the executive organs of the Agency. If adopted, this type of membership would be of a relatively short duration. "Observer status" is a device, adopted by a number of specialized agencies, to accommodate entities that do not qualify for regular membership. Through this device, an ISMA could establish a formal link with interested intergovernmental and other international organizations and entities.

410. Regular membership in ISMA would be open to any State member of the United Nations or of one of its specialized agencies. Admission to membership would be a prerogative of the plenary organ of ISMA. The voting techniques in regard to admission, as well as the terms of withdrawal, suspension and expulsion from membership can be left to future negotiations.

### (B) Organs of an ISMA

411. The structure of each existing intergovernmental organization largely reflects its origin and its particular functions and technology. Within the United Nations system no two agencies have the same organizational structure, although all the major ones have a plenary organ, an executive organ and a secretariat. To that extent, at least, the organizational structure of an ISMA as proposed below follows the practice of the specialized agencies.

#### (a) The Assembly

412. The Assembly would be the plenary organ of ISMA in which all States parties to the Constitutive Act would be represented, each having one vote.

#### (i) Powers and functions

413. The principal powers and functions of the Assembly would include; (a) the determination of general policies and long-term objectives of an ISMA; (b) admission, suspension and expulsion of members; (c) adoption of the budget; revision of the constitutive instrument of the Agency; (d) approval of formal agreements between ISMA and other intergovernmental organizations and States; (e) election of members to the executive organ of ISMA (the Council); (f) approval of the appointment of the principal administrative officer of the Agency (Director-General); (g) approval of nominees for the arbitral tribunal of ISMA; and (h) consideration of annual reports.

#### (ii) Periodicity of sessions

414. Regular sessions of the Assembly should not be held more than once a year, preferably once every two years. Extraordinary sessions should be held when a majority of the members so request, or upon the request of the Council.

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(iii) Voting

415. In the Assembly each Member State should have one vote. The voting techniques, including the nature of decision-making on substantive and procedural matters, can be left to future negotiations.

(b) The Council

(i) Composition

416. In order to assure efficient functioning of an ISMA, decisions concerning the day-to-day activities of the Agency must be made by an organ consisting of a limited number of States - the Council. While the size of the Council will have to be decided by States participating in the negotiations on the establishment of the Agency, the unique nature of an ISMA's functions would strongly suggest a relatively small body. Experience of other intergovernmental organizations, with larger executive organs, provides persuasive evidence in favour of a small Council. Apart from the size of the Council, one of the most delicate questions relating to the structure of ISMA which the negotiators will have to settle is the formula for the appointment of the members of the executive organ. It is clear that the paramount consideration in elaborating this formula must be the smooth functioning of the Agency. However, an arrangement must be sought that will guarantee the equitable representation of member States on the Council. Comparable international (intergovernmental) organizations could serve as an example.

(ii) Powers and functions

417. The principal powers and functions of the Council should include: (a) the implementation of the Assembly's decisions; (b) initiation of ISMA monitoring; (c) control over the content, format and dissemination of ISMA Reports; (d) formulation of policies and programmes; (e) drafting budget proposals; (f) planning and conduct of negotiations with other intergovernmental organizations and States; (g) appointment of the Director-General of ISMA, subject to the approval by the Assembly; (h) selection of persons to serve on the ISMA arbitral tribunal subject to the approval by the Assembly; (i) preparation of annual reports; (j) supervision over the Secretariat; and (k) appointment of senior officials in the Secretariat.

(iii) Frequency of Sessions

418. The nature of an ISMA's function would require that its Council be ready at all times to respond to a request for action by the Agency, for international crises can erupt any time. The Agency's worth would, in fact, be judged by the swiftness of its response to a call for action. For these reasons it is imperative to establish the Council would have to be established as an organ whose members are permanently available at the ISMA headquarters. The frequency of regular sessions to be held by the Council, when no emergencies are involved, could be determined by the negotiating States at a later date.

(iv) Voting

419. The voting procedure in the Council must be fair and, at the same time assure efficient conduct of business. Most importantly, the voting procedure must allow the Council to reach its decision on urgent matters (e.g. a request for crisis monitoring) without undue delay. The determination of the precise voting formula to govern the Council's decision-making should be left to the negotiating States.

(c) The Secretariat of an ISMA

(i) Director-General

420. The Director-General would be the chief administrative officer of ISMA and its legal representative. Appointed by the Council, with the approval of the Assembly, he should be a person of proven integrity and efficiency, as well as of high technical competence in a field related to the function of an ISMA mission. The Director-General should hold office for a fixed term, not exceeding five years, and should be eligible for additional terms. His principal functions would include: (a) the management of the Agency's work; (b) direction, supervision and hiring of the staff; (c) preparation of reports and studies concerning the work of an ISMA; and (d) negotiation of agreements (when specifically so authorized by the Council) and contracts on behalf of the Agency.

(ii) The staff of an ISMA

421. The recruitment of properly qualified and responsible personnel will be one of the most important and demanding tasks facing ISMA. In this endeavour, ISMA could use the criteria established by the United Nations Charter for the hiring of staff. Article 101(3) of the Charter prescribes: "The paramount consideration in the employment of the staff and in the determination of the conditions of service shall be the necessity of securing the highest standards of efficiency, competence and integrity. Due regard shall be paid to the importance of recruiting the staff on as wide a geographical basis as possible". Furthermore, it should be one of the priority tasks of the Agency, from the very beginning of its existence, to promote the development of human resources of its members, by providing facilities for education and training of their nationals as appropriate.

VI. The financing of an ISMA

422. Virtually all the constitutions of the intergovernmental organizations provide for the payment of membership fees. However, the Constitutive Act of an ISMA should allow, in addition to the mandatory contributions, other sources of financing. They would include: voluntary contributions, such as contributions in kind, taking the form of the provision of technical facilities to an ISMA by the States engaged in space activities; and counterpart funds contributed in return for services rendered by the Agency (e.g. where the Agency monitors an agreement concluded by a State). Member States should also be permitted to fulfil part of their financial obligations toward the Agency by providing it with free facilities (e.g. the land for ground stations; equipment).

VII. Settlement of disputes within an ISMA

(A) Certain imperatives

423. The dispute-settlement machinery and procedures for an ISMA must be of a kind that provide reasonable assurance of informed, just and, above all, expeditious decisions. Delay in resolving some disputes, especially those relating to a request for monitoring a crisis situation, could easily frustrate or seriously compromise the very raison d'être of the Agency.

424. Without prejudice to the resort to the International Court of Justice (ICJ), or any other traditional forum of dispute-settlement the highly technical and sensitive nature of a good many anticipatable disputes, involving the security and international

reputation of a State, as well as the need for swift decisions, may make it undesirable to leave resolution of such disputes to bodies outside the Agency. However, to be able to seek the intervention of the ICJ, an ISMA would first have to become a specialized agency of the United Nations. As such it would be entitled to a non-binding advisory opinion. According to Article 34 of the ICJ Statute, only States can be parties to a contentious dispute before the Court and for them the decision of the Court is binding. Bearing the above in mind, it would seem desirable to establish a special machinery within an ISMA for the settlement of disputes. In considering this machinery, account should be taken of the arrangements discussed in Section (C) below.

### (B) Parties to and the nature of possible disputes

425. Given the sensitive character of an ISMA's function, the possibility of frequent disputes between Member States and the Agency, as well as between Member States themselves, cannot be ignored. Both types of disputes would almost invariably involve the interpretation and the application of the Constitutive Act of an ISMA and/or the annexes thereto, if any. More specifically, disputes between Member States and ISMA might include:

(1) non-fulfilment by a Member State of its financial obligations toward the Agency;

(2) non-compliance with a decision of an organ of ISMA;

(3) violation of the confidentiality of data and/or information, either by ISMA or by a Member State;

(4) inaccurate interpretation of data information;

(5) use of improper methods employed by an ISMA to obtain data information (e.g. without the knowledge of the State directly concerned, or from a source to which the complainant State objects);

(6) initiation of monitoring by satellite without the knowledge or consent of the Member State placed under surveillance;

(7) excessive duration of monitoring (e.g. long after the "crisis situation" has ended);

(8) failure by an ISMA to act upon a request by a Member State or unduly late action;

(9) ISMA's acts in excess of the authority granted the Agency by its constitutive instrument;

(10) carelessness on the part of an ISMA in negotiating agreements with other intergovernmental organizations, States and private entities, causing damage to the interests of the Agency; and

(11) discrimination or favouritism by an ISMA in awarding contracts facilities for services required by the Agency.

426. Many of the disputes listed above could also arise between two or more Member States. In particular, a disagreement could be envisaged when a Member State, claiming a "crisis situation" with a neighbouring Member State, requests an ISMA to begin monitoring the region of the alleged crisis. A dispute could also arise when one Member State formally accuses another of non-fulfilment of the obligations under the Constitutive Act of an ISMA. All those disagreements could be submitted for final and binding resolution to ISMA's dispute-settlement organ.

(C) Machinery

(a) Provisions in the constitutive instruments of existing international organizations

427. There are no special provisions in the United Nations Charter for the settlement of disputes relating to the validity of acts of its principal organs. Such provisions, however, are not uncommon in the constitutive instruments of the specialized agencies. The constitutions of intergovernmental organizations related to the United Nations employ a great variety of methods for settling disputes between Members and the organization and between Members themselves. Some of the dispute-settlement arrangements of special relevance to an ISMA adopted by the Constitutions of various international organizations are outlined below.

428. The Statute of IAEA provides that any question or dispute concerning the interpretation or application of the Statute, which is not settled by negotiations, shall be referred to the ICJ in conformity with the Statute of the Court, unless the parties concerned agree on another mode of settlement. In addition, the General Conference and the Board of Governors are separately empowered to submit any legal question arising within the scope of the Agency's activities to the ICJ for an advisory opinion (Article XVII).

429. The Convention of the World Meteorological Organization stipulates simply that any dispute concerning the interpretation or application of the Convention which cannot be settled by negotiation or by the WMO Congress (the supreme organ of the agency), shall be referred to an independent arbitrator appointed by the President of the ICJ, unless the parties agree to another mode of settlement.

430. The INMARSAT Convention contains elaborate provisions on the settlement of disputes, supplemented by an annex to the Convention on the "procedures for the settlement of disputes". Article 31 of the Convention prescribes that the settlement of disputes arising between the parties, or between the parties and the organization, relating to rights and obligations under the Convention should first be attempted through negotiation. If within a year the parties fail to reach settlement and if the parties have not agreed to submit the dispute to the ICJ, or to some other procedure, the dispute may, if the parties to the dispute consent, be submitted to arbitration. However, unless otherwise agreed, disputes arising between INMARSAT and one or more parties under agreements concluded between them, if not settled by negotiation within a year, shall at the request of any party to the dispute, be submitted to an arbitral tribunal established under the Convention. The tribunal consists of three members, with each disputant nominating one arbitrator and the two thus selected nominating a third arbitrator, who acts as president of the tribunal. The decision of the tribunal is binding on all the disputants.

431. The dispute-settlement method adopted by the Convention on International Civil Aviation merits attention for the role it assigns in the dispute-settlement to the ICAO Council and because it has been tested in practice. Article 84 of the

Convention provides that any disagreement between two or more Member States which cannot be resolved by negotiation, "shall, on the application of any State concerned in the disagreement, be decided by the Council". While the Convention does not explicitly state so, it is safe to assume that, unless reversed or modified on appeal, the decision of the Council is final and binding on the parties. However, according to the same Article 84, any contracting State may "appeal from the decision of the Council to an ad hoc arbitral tribunal agreed upon with the other parties to the dispute or to" the ICJ; still further reducing the efficacy of the Council's adjudicatory function is the provision of Article 86 which stipulates that "decisions of the Council shall, if appealed from, be suspended until the appeal is decided". Only the decisions of the ICJ and of an arbitral tribunal are final and binding. Given its large membership, consisting since 1976 of 33 Member States, and an extensive array of responsibilities under the Convention, it is not surprising that the Council has not been an effective instrument of dispute-settlement. It should also be noted that the Convention does not provide for the settlement of disputes between ICAO and its Member States.

432. The complex machinery for the settlement of disputes established under the draft-Convention on the Law of the Sea 28/ offers the contracting States a variety of choices. Article 287 of the draft-Convention grants the parties a freedom to choose, "by means of a written declaration, one or more of the following means for the settlement of disputes relating to the interpretation or application of this Convention: (a) The Law of the Sea Tribunal constituted in accordance with Annex VI; (b) The International Court of Justice; (c) An arbitral tribunal constituted in accordance with annex VII; (d) A special tribunal constituted in accordance with annex VIII for one or more of the categories of disputes specified therein".

433. A solution which might be of interest to an ISMA appears to be the one adopted by the Convention on the establishment of the European Space Agency (ESA). Article XVII of the Convention provides that any dispute between two or more Member States, or between any of them and the Agency, concerning the interpretation or application of the Convention or its annexes, and any dispute which is not settled by the Council, shall, at the request of any party to the dispute, be submitted to arbitration. The Arbitration Tribunal provided for by the Convention consists of three members. Each party nominates one arbitrator and the two so selected nominate the third arbitrator who acts as the chairman of the Tribunal. The award of the Tribunal by a majority of its members is final and binding, with no appeal allowed.

434. None of the various arrangements outlined above seems fully responsive to the needs of an ISMA. With the exception of the ESA procedure, they all allow for lengthy delays before a settlement is reached, and some, in addition, prescribe procedures so cumbersome and complex as to invite a dispute about the proper mode of dispute-settlement (e.g. INMARSAT). Furthermore, as the experience of ICAO demonstrates, the existing procedures do not function well. All these reasons would strongly suggest the need for an innovative approach.

435. Initially, a solution to a dispute within ISMA should be sought through prompt, direct consultations between the disputing parties. This is an accepted and widely followed method of dispute-settlement, long recognized in international law. When

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28/ Draft Convention on the Law of the Sea (Informal Text) A/CONF.62/WP10/Rev.3 and Add.1. 27 August 1980.

such consultations fail to resolve a dispute within the time appropriate to the circumstances of a particular controversy, the dispute should be promptly submitted to a special dispute-settlement organ established by the Constitutive Act text of an ISMA.

### (b) Nature and composition of the dispute-settlement organ of an ISMA

436. At least four possibilities can be envisaged: (a) the establishment of a permanent arbitral body, comparable to the ICJ, as a principal organ of an ISMA; (b) an *ad hoc* arbitral body, where arbitrators are selected by the parties to a dispute, with an independent chairman chosen by the nominees of the disputants; (c) the executive organ of an ISMA - the Council - acting in adjudicatory capacity (like the ICAO Council); and (d) a panel of arbitrators nominated by Member States, appointed by ISMA's Council and approved by the Assembly, from which parties select the agreed number of arbitrators for each dispute (an arrangement comparable to that of the Permanent Court of Arbitration).

437. While none of these options is flawless, arrangements under (a), (b) and (c) would seem less satisfactory than option (d). A permanent arbitral body attached to ISMA could be too costly, would allow Member States no say in the selection of arbitrators, and would run the risk of very close identification with the administration of the Agency. Moreover, it might be difficult to find appropriately qualified persons willing to serve for years in the headquarters of an ISMA. An *ad hoc* arbitral body on the other hand, would give too much freedom to the contending parties in the selection of arbitrators; this could delay the process of empanelling and lead to difficulties and friction in the decision-making. Given its composition, the ability of the ISMA Council to adjudicate a dispute with the required impartiality would be seriously questioned. Since its members would be the representatives of Member States, they could not avoid being influenced by the governments they represent, or at least give the appearance of such influence.

438. The solution most likely to satisfy the needs of ISMA and find support among Member States is one under option (d), calling for the establishment of a relatively large panel of arbitrators. The panel as a whole, as well as when an agreed number of its members sit to decide a particular dispute, should consist of a mix of persons each with a recognised competence in either the technical fields relevant to the operation of the Agency or in the law governing its activities. Both categories of arbitrators should have appropriate knowledge of the objectives of an ISMA, and be persons of the highest integrity. An appropriate number of arbitrators, in rotating order, should be ready at a moment's notice to assume their duty on the tribunal, in order to assure the uninterrupted functioning of an ISMA. The award of the tribunal would be final and binding, with no right of appeal.

439. Future negotiations on the Constitutive Act of an ISMA would have to deal with questions such as: the total number of arbitrators to be appointed (the Statute of the Law of the Sea Tribunal provides for 21 members); their term of office (nine years on the ICJ and the Law of the Sea Tribunal); the size of the panel adjudicating a particular dispute; the nationality of members (should only nationals of Member States be eligible, or any qualified person, regardless of nationality); the amount of remuneration for service; conditions of access to, and the publication of, the proceedings before the tribunal; and the appointment of a full-time president or administrator of the tribunal.

440. Conceivably, within the United Nations disarmament machinery a thought might be given to the possibility of establishing some time in the future a single dispute settlement organ for disagreements arising out of the multilateral arms control

and disarmament agreements in force. Should such an organ come into being, it could be used by an ISMA. On the other hand, if an ISMA should come into being before such an organ is constituted, its dispute-settlement practice could provide invaluable experience to States negotiating a new tribunal.

## CHAPTER THREE: FINANCIAL IMPLICATIONS

### I. General

441. Since a variety of technical options, possibilities and combinations of options are feasible when implementing various phases of an ISMA, precise or quantitative estimates of costs are difficult to make. Such a variety of technical possibilities, when viewed in conjunction with different policies, possible reactions and co-operative attitudes of States towards the Agency, would necessarily lead to a broad range in cost estimates. Several financial estimates of relevance to the development of an ISMA have been made by various groups (1-5). Any estimates of costs for a project like that of establishing an ISMA are difficult to make since they would have to be based on different assumptions and methods. To make assumptions or choices as a basis for a more elaborate analysis of the costs would, in fact, amount to a design of what the Agency should look like. The Group neither found it possible, nor considered it its task to make such choices. However, in an attempt to give some idea of what financial implications the establishment of an ISMA and the implementation of the different phases could entail, some approximate costs are indicated below. The cost figures presented here relate to 1980 values. 29/

442. Should the international community decide to proceed with the establishment of an ISMA, one of the first steps recommended by the Group would be to commission a detailed engineering and related cost study which should be prepared by a specialized professional organization or establishment.

### II. Phase I

443. In this phase an ISMA would function as an Image Processing and Interpretation Centre (IPIC) with technical facilities as described in Sections III.A. and III.D. of Chapter I (Technical Implications).

444. Since the task of ISMA's IPIC would be quite different from other existing national or regional centres for processing satellite data for natural resources assessments, utilization by an ISMA of such national or regional centres would be rather limited. It would be highly desirable, in the initial phases of ISMA's operation, to acquire and operate its own IPIC. The Agency would thus acquire and operate its own:

- Data processing subsystem (data formatting, correction and preprocessing);
- Data management subsystem (reproduction, storage, archiving, cataloguing and dissemination);
- Data analysis and interpretation subsystem (including computer and machine-aided techniques, as well as human deductive and inductive analysis).

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29/ See references contained in Annex VI.

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445. Capital investment for acquiring such systems and subsystems (exclusive of space and building costs) may amount to approximately 3 million dollars (1980 prices). The operational costs for Phase I of an ISMA, based on the estimates of data volumes to be processed and analysed, as well as on technical and manpower resources needed, as outlined in Sections III.D (b) (iii) and III.D (b) (v) c. Chapter One, would be approximately in the range of 25 to 30 million dollars per year. The fees that would have to be paid, if any, to the States providing data would also have to be taken into consideration.

## III. Phase II

446. In this phase, the cost estimate is based on the assumption that ISMA would acquire and operate its own ground receiving stations for receiving data. Most estimates give a range anywhere between 6 to 8 million dollars as the capital cost per station, and approximately two million dollars per station per year as the operational cost.

447. In case an ISMA has to set up and operate a global system of 10 stations, with data links, the initial investment cost would be in the range of 60 to 80 million dollars. The annual operational costs for these 10 stations would be about 20 million dollars. However, these cost figures can be significantly reduced if member States possessing space systems and/or receiving stations would be willing to make them available to the Agency as and when needed. The fees to be paid to States permitting access to their satellites would also have to be taken into account.

## IV. Phase III

448. Section III.C. of Chapter One gives a description of this stage based on the assumption that an ISMA may have to establish its own space segment as a supplement to national systems. The range of cost figures for this segment is as follows:

(a) The total cost of launching a single-satellite for area monitoring (including cost of R & D) varies between 300 to 400 million dollars (spread over a period of four to six years). To ensure adequate area coverage, the Agency may typically have to launch a three-satellite system carrying combinations of optical, infra-red and radar-type, satellites. Cost figures could then be in the range of 0.9 to 1.2 billion dollars.

(b) Cost of satellite renewal (assuming one launching every two to three years) and of systems management (for example operations personnel, R & D personnel, software development contracts, equipment maintenance, in-house R & D) is estimated to vary in the range 50-200 million dollars per year.

449. Cost estimates for launching and operation of a single low-altitude manoeuvrable satellite for close-look, including R & D and other technical facilities needed for command and control of the satellite, may be approximately 1.5 billion dollars, spread over a 10-year period. Satellite renewal and systems management, based on a launching every two years, would cost approximately 120 million dollars per year. As far as less expensive alternatives to the manoeuvrable close-look satellite are concerned (for example, a "launch on request" system to cover specific targets with very high

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resolution), the Group felt that precise cost estimates would need a detailed engineering examination by specialists who would have to consider the relative merits of all systems from the cost benefit angle.

450. In all the above options for space segment, development and operational costs can be substantially reduced (by several hundreds of million dollars) if the ISMA is allowed to use instruments, equipment, satellite platforms, etc., developed under national programmes.

## Annex I

## GROUP OF GOVERNMENTAL EXPERTS ON THE IMPLICATIONS OF ESTABLISHING AN INTERNATIONAL SATELLITE MONITORING AGENCY

### LIST OF EXPERTS

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NOTE: The experts wished to put on record their appreciation of the contribution to their work by the advisors to individual experts. The Group at various times benefited of the special knowledge of the following advisors: Mr. A. CARNELUTTI (France) Mlle L. GHAZERIAN (France) Mr. Charles A. GRIFFITH (France) Mr. Daniel HADOT (France) Mr. Rafael L. MARIANI (Argentina) Mr. B. MICEVIC (Yugoslavia) Mr. E. MONDRE (Austria) Mr. Lars NORBERG (Sweden) Mr. Torleiv ORHAUG (Sweden) Mr. Adama OUEDRAOGO (Upper Volta) Mr. Aly A. SADEK (Egypt).

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## Annex II

## GLOSSARY FOR CHAPTER ONE: TECHNICAL IMPLICATIONS

| | |
|---|---|
| Apogee: | The point in an orbit of an Earth satellite which is farthest away from the Earth |
| Active sensor: | A sensor which radiates electromagnetic energy at objects and detects them by observing the reflected radiation |
| Bit: | Binary digits for data representation in computers (uses combinations of two digits, zero and one, for representing any numerical value) |
| Computer compatible tapes (CCT) | Digital data stored on magnetic tapes in such a way that it can be directly read by normal computers |
| Contrast ratio: | The ratio of the brightness of an object in a scene to that of the background. The ratio may depend on the spectral band in which it is measured |
| Data: | The raw signals including imagery generated from an observation satellite |
| Description: | Conversion of encrypted data to readable data |
| Demodulator: | Data transmitted from a satellite by a radio signal is converted into the original form by an instrument called a demodulator |
| Density slicing: | Representation of an image at a particular tonal level |
| Encryption: | Transformation of data into an unusable form unless the rules of transformation are known (encryption key) |
| Ephemary: | A table of predicted positions of bodies in the solar system |
| Geometric error: | Distortion of forms in an image |
| Geostationary/ Geosynchronous orbit: | When the satellite orbits the Earth at the same speed as the rotation of the Earth with its orbital inclination zero, the orbit is called geosynchronous or geostationary orbit and the satellite appears stationary with respect to the Earth |
| Ground resolution: | This is the ground dimension equivalent to one line at limit of resolution |
| Ground truth: | True information against which recorded data can be compared |
| Housekeeping: | Information representing the state of a space segment; for example, state of a satellite platform, sensor |

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|---|---|
| Image enhancement: | The process of emphasizing certain aspects of imagery data not easily observable by human eye |
| Instantaneous field of view (IFOV): | This is defined as the size of the spot on the ground which just fills the area of the sensor of a scanner at the instant of observation |
| Lifetime: | The period of time during which instruments on board a satellite remain functioning or the period from take-off to decay of the satellite |
| Linear filtering: | A particular processing algorithm for which pixel values are combined by addition (or subtraction) only; used for example in enhancing features such as lines, contours, etc. |
| Microbarograph: | An instrument used to record small changes in pressure |
| Microdensitometer: | An instrument used to measure small tonal changes in an image |
| Multispectral scanner (MSS): | An instrument used to produce imagery data by scanning the Earth's surface below the satellite across the orbital path in two or more wavelength bands |
| Optronic: | The technology of making optical equipment using both optical and electronic components |
| Orbit: | The path of a satellite under the influence of the Earth's gravitational force; the path is closed, that is the satellite returns periodically to the same point in the path |
| Passive sensor: | A sensor which detects objects by observing the natural radiation which is either reflected or emitted by the objects |
| Perigee: | The point in an orbit of the Earth satellite which is closest to the Earth |
| Photomation: | Transformation of digital imagery data into a photographic image |
| Pixel: | Picture elements |
| Polar Orbit | Satellite orbit such that the orbital plane contains the Earth's axis of rotation |
| Preprocessing: | Conversion of data: (1) by using calibration information; (2) into suitable format; and (3) enhancing certain features in the data for subsequent analysis |

| | |
|---|---|
| **Processing algorithm:** | Set of rules describing the precise calculations to be carried out on any data (implemented by a computer programme) |
| **Pseudocolouring:** | Assignment of (and presentation of) colours to imagery data (e.g. assignment of colour to various tonal values in an image); (tonal values of non-visual imagery data (for example, an infra-red image or microwave image) are visualised using colours; this process is called false colouring) |
| **Radiometer:** | An instrument which detects natural electro-magnetic radiation (for example, in the infra-red or microwave regions) |
| **Return Beam Vidicon (RBV)** | A camera which essentially produces black-and-white or colour television images |
| **Sun-synchronous orbit** | A polar orbit with orbital parameters chosen in such a way that the satellite crosses the Earth's equatorial plane at the same local time |
| **Synthetic Aperture Radar (SAR):** | This is a side-looking radar with a relatively short antenna which is made to behave like a very long one with a narrow beam; a long antenna can be synthesized by taking advantage of the motion of the platform (a satellite) |
| **Telemetry:** | Transmission of data using microwaves (for example, housekeeping data, imagery data from satellite sensors etc.) |
| **Thematic mapper:** | An MSS with several spectral bands to provide thematic maps |
| **Thematic processing:** | Processing of MSS imagery data by combining measurements made in variousspectral bands to produce imagery (or maps) showing various "themes" (for example, forests, agricultural and urban areas) |
| **Trackball:** | A specific input device for communication with a computer; the trackball controls the position of a pointer (or cursor) on the image display screen and the computer can be programmed to read the position of the cursor; in this way, the computer can be instructed to choose a certain programmed sequence (the display showing various options) or it can be instructed to process a particular part of an image displayed |
| **Travelling microscope:** | A microscope which scans over a photographic image |

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## Annex III

## LIST OF ABBREVIATIONS

The following abbreviations are used in the body of the report. They are listed in alphabetical order.

| | |
|---|---|
| APT | Automatic Picture Transmission |
| ASDAR | Aircraft to Satellite Data Relay |
| AVHRR | Advanced High-Resolution Radiometer |
| CB | Chemical and Biological |
| CCT | Computer Compatible Tape |
| DAS | Data Analysis Subsystem |
| DCP | Data-collection Platform |
| DMS | Data Management Subsystem |
| DPS | Data Processing Subsystem |
| DST | Direct Sounding Transmission |
| ECA | Economic Commission for Africa |
| ENMOD | Environmental Modification |
| EROS | Earth Resources Observation System |
| ESA | European Space Agency |
| ESRIN | European Space Research Information Network |
| FGGE | First GARP Global Experiment |
| GARP | Global Atmospheric Research Programme |
| GDTA | Groupement pour le Dévéloppement de la Télédétection Aérospatiale |
| GMS | Geostationary Meteorological Satellite |
| GOES | Geostationary Operational Environment Satellite |
| GOS | Global Observation System |
| GP | General Purpose |
| GTS | Global Telecommunication System |
| HALO | High-altitude Large Optics |
| HCMM | Heat Capacity Mapping Mission |
| HDDT | High Density Digital Tapes |
| HRPT | High-Resolution Picture Transmission |
| IAEA | International Atomic Energy Agency |
| IONDS | Integrated Operational Nuclear Detection System |
| IPIC | Image Processing and Interpretation Centre |
| IR | Infra-red |
| IRS | Indian Remote Sensing |

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| | |
|---|---|
| IFOV | Instantaneous Field of View |
| IUS | Intertial Upper Stage |
| LASS | Land Application Satellite Systems |
| MOS | Marine Observation |
| MSS | Multi-spectral Scanners |
| NASA | National Aeronautics and Space Agency (United States of America) |
| NDPF | NASA Data Processing Facility |
| NDSDA | National Space Development Agency (Japan) |
| NOAA | National Oceanic and Atmospheric Administration |
| NPT | Treaty on the Non-Proliferation of Nuclear Weapons |
| OPANAL | Agency for the Prohibition of Nuclear Weapons in Latin America |
| RBV | Return-Beam Vidicon |
| RESTES | Remote Sensing Technology Centre of Japan |
| SAR | Synthetic Aperture Radar |
| SARAD | Satellite Radiation Data (WMO international code form for transmission of satellite-derived radiance data) |
| SATEM | ..... |
| SEO | Satellite Earth Observation |
| SMS | Satellite Meteorological System |
| SPOT | Système Probatoire d'Observation de la Terre |
| SSUS | Spinning Solid Upper Stage |
| TDRSS | Tracking and Data Relay Satellite System |
| TIROS | Television Infra-red Observation Satellite |
| TOVS | TIROS Operational Vertical Sounder |
| VIS | Visual |
| WEFAX | Weather Facsimile (charts broadcasts via geostationary satellites) |
| WMO | World Meteorological Organization |
| WWW | World Weather Watch |

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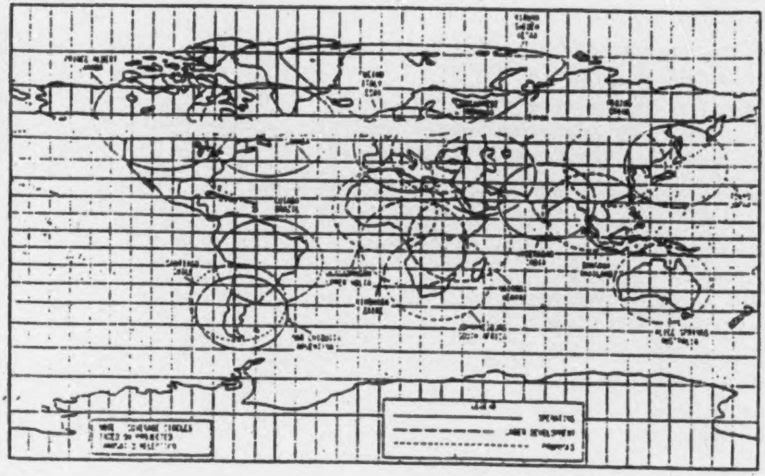
## Annex IV

## MAPS AND CHARTS RELATED TO CHAPTER ONE

Figure 1. The status of Landsat ground stations.



### LANDSAT GROUND STATION STATUS

| Country | Agreement Signed | Data Reception | Data Processing |
|---|---|---|---|
| Argentina | 1976 | 1980 | 1980 |
| Australia | 1979 | 1980 | 1980 |
| Brazil | 1973 | 1973 | 1974 |
| Canada | | | |
| Prince Albert | 1972 | 1972 | 1972 |
| Shoe Cove | 1976 | 1977 | 1977 |
| Chile* | 1975 | - | - |
| China | 1980 | - | - |
| India | 1978 | 1979 | 1980 |
| Iran* | 1974 | - | - |
| Italy (ESA) | 1974 | 1975 | 1976 |
| Japan | 1979 | 1979 | 1979 |
| Sweden (ESA) | 1978 | 1978 | 1979 |
| Thailand | 1979 | - | - |
| Zaire* | 1975 | - | - |

*Note: Chile and Zaire have thus far been unable to fund the establishment of their proposed Landsat stations. The Landsat station in Iran was largely completed and began receiving some test data in late 1978. However, the station ceased operations in early 1979.

Source: Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options U.S. Department of Commerce, Rockville, Md., U.S.A.

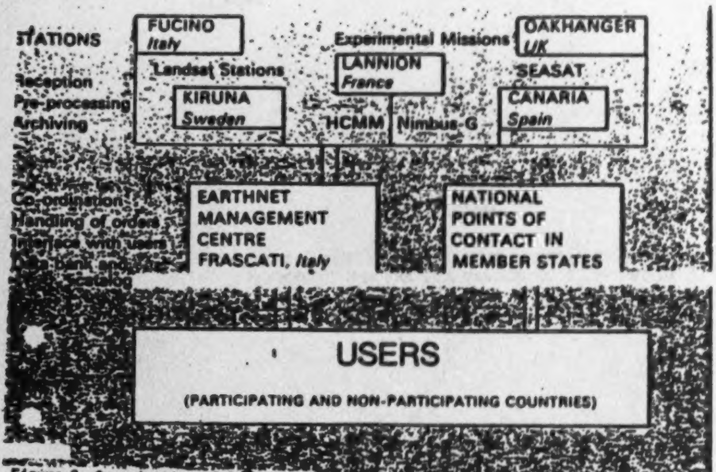

STATIONS
Reception
Pre-processing
Archiving
FUCINO
Italy
Landsat Stations
KIRUNA
Sweden
Experimental Missions
LANNION
France
HCMM
Nimbus-G
OAKHANGER
UK
SEASAT
CANARIA
Spain
Co-ordination
Handling of orders
Interface with users
EARTHNET
MANAGEMENT
CENTRE
FRASCATI, Italy
NATIONAL
POINTS OF
CONTACT IN
MEMBER STATES
USERS
(PARTICIPATING AND NON-PARTICIPATING COUNTRIES)

Figure 2. Organisation of Earthnet

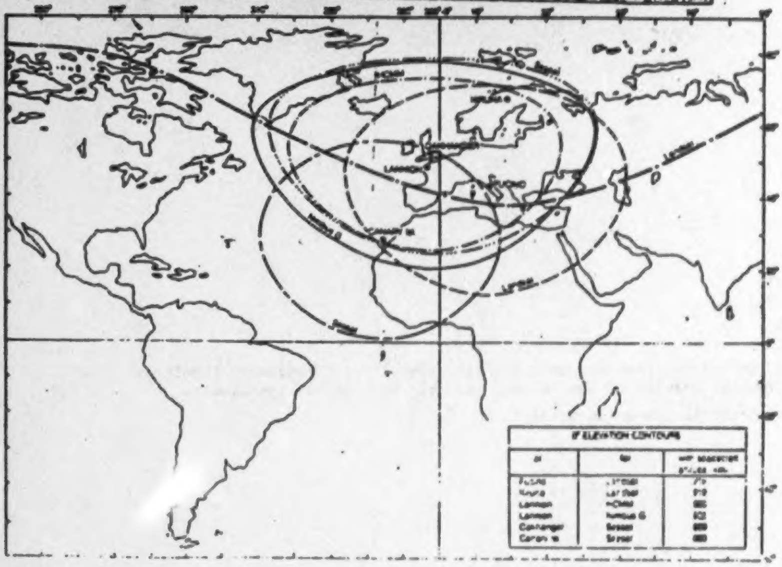

HCMM
LANNION
NIMBUS G
LANDSAT
ELEVATION CONTOURS
Fucino
Kiruna
Lannion
Lannion
Oakhanger
Canaria
Landsat
Landsat
HCMM
Nimbus G
Seasat
Seasat

Figure 3. Approximate coverage zones of the Earthnet stations for the various observational satellites

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## Annex V

# VERIFICATION CLAUSES CONTAINED IN EXISTING AGREEMENTS IN THE FIELD OF DISARMAMENT AND ARMS CONTROL *

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* Reproduced from document A/AC.187/109 of the Preparatory Committee for the Special Session of the General Assembly Devoted to Disarmament.

Foot-notes have been up-dated.

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## Provisions regarding verification in existing agreements in the field of disarmament and arms limitation 1/

I. Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare (1925):

No provision for verification.

II. Antarctic Treaty (1959):

Article VII:

1. In order to promote the objectives and ensure the observance of the provisions of the present Treaty, each Contracting Party whose representatives are entitled to participate in the meetings referred to in Article IX of the Treaty shall have the right to designate observers to carry out any inspection provided for by the present Article. Observers shall be nationals of the Contracting Parties which designate them. The names of observers shall be communicated to every other Contracting Party having the right to designate observers, and like notice shall be given of the termination of their appointment.

2. Each observer designated in accordance with the provisions of paragraph 1 of this article shall have complete freedom of access at any time to any or all areas of Antarctica.

3. All areas of Antarctica, including all stations, installations and equipment within those areas, and all ships and aircraft at points of discharging or embarking cargoes or personnel in Antarctica, shall be open at all times to inspection by any observers designated in accordance with paragraph 1 of this Article.

4. Aerial observation may be carried out at any time over any or all areas of Antarctica by any of the Contracting Parties having the right to designate observers.

5. Each Contracting Party shall, at the time when the present Treaty enters into force for it, inform the other Contracting Parties, and thereafter shall give them notice in advance, of

(a) all expeditions to and within Antarctica, on the part of its ships or nationals, and all expeditions to Antarctica organised in or proceeding from its territory;

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1/ Agreements are listed in chronological order.

/...

(b) all stations in Antarctica occupied by its nationals; and

(c) any military personnel or equipment intended to be introduced by it into Antarctica subject to the conditions prescribed in paragraph 2 of Article I of the present Treaty.

Article IX, paragraph 1, provides that:

Representatives of the Contracting Parties named in the preamble to the present Treaty shall meet at the City of Canberra within two months after the date of entry into force of the Treaty, and thereafter at suitable intervals and places, for the purpose of exchanging information, consulting together on matters of common interest pertaining to Antarctica, and formulating and considering and recommending to their Governments, measures in furtherance of the principles and objectives of the Treaty, including measures regarding, inter alia, facilitation of the exercise of the rights of inspection provided for in Article VII of the Treaty.

III. Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (1963): since it was envisaged that verification under this Treaty would be carried out by national means only, no provisions for verification were included in the text.

IV. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967):

Article X:

In order to promote international co-operation in the exploration and use of outer space, including the moon and other celestial bodies, in conformity with the purposes of this Treaty, the States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States.

The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.

Article XII:

All stations, installations, equipment and space vehicles on the moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.

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V. Treaty for the Prohibition of Nuclear Weapons in Latin America (1967): 2/
Articles 12-16:

1. For the purpose of verifying compliance with the obligations entered into by the Contracting Parties in accordance with article 1, a control system shall be established which shall be put into effect in accordance with the provisions of articles 13-18 of this Treaty.

2. The control system shall be used in particular for the purpose of verifying:

(*a*) That devices, services and facilities intended for peaceful uses of nuclear energy are not used in the testing or manufacture of nuclear weapons,

(*b*) That none of the activities prohibited in article 1 of this Treaty are carried out in the territory of the Contracting Parties with nuclear materials or weapons introduced from abroad, and

(*c*) That explosions for peaceful purposes are compatible with article 18 of this Treaty.

Each Contracting Party shall negotiate multilateral or bilateral agreements with the International Atomic Energy Agency for the application of its safeguards to its nuclear activities. Each Contracting Party shall initiate negotiations within a period of 180 days after the date of the deposit of its instrument of ratification of this Treaty. These agreements shall enter into force, for each Party, not later than eighteen months after the date of the initiation of such negotiations except in case of unforeseen circumstances or *force majeure*.

1. The Contracting Parties shall submit to the Agency and to the International Atomic Energy Agency, for their information, semi-annual reports stating that no activity prohibited under this Treaty has occurred in their respective territories.

2. The Contracting Parties shall simultaneously transmit to the Agency a copy of any report they may submit to the International Atomic Energy Agency which relates to matters that are the subject of this Treaty and to the application of safeguards.

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2/ As at August 1980, 20 agreements for the application of safeguards pursuant to this Treaty are in force or being negotiated. These also cover NPT obligations for States Parties to NPT.

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3. The Contracting Parties shall also transmit to the Organisation of American States, for its information, any reports that may be of interest to it, in accordance with the obligations established by the Inter-American System.

1. With the authorization of the Council, the General Secretary may request any of the Contracting Parties to provide the Agency with complementary or supplementary information regarding any event or circumstance connected with compliance with this Treaty, explaining his reasons. The Contracting Parties undertake to co-operate promptly and fully with the General Secretary.

2. The General Secretary shall inform the Council and the Contracting Parties forthwith of such requests and of the respective replies.

1. The International Atomic Energy Agency and the Council established by this Treaty have the power of carrying out special inspections in the following cases:

(a) In the case of the International Atomic Energy Agency, in accordance with the agreements referred to in article 13 of this Treaty:

(b) In the case of the Council:

(i) When so requested, the reasons for the request being stated, by any Party which suspects that some activity prohibited by this Treaty has been carried out or is about to be carried out, either in the territory of any other Party or in any other place on such latter Party's behalf, the Council shall immediately arrange for such an inspection in accordance with article 10, paragraph 5.

(ii) When requested by any Party which has been suspected of or charged with having violated this Treaty, the Council shall immediately arrange for the special inspection requested in accordance with article 10, paragraph 5.

The above requests will be made to the Council through the General Secretary.

2. The costs and expenses of any special inspection carried out under paragraph 1, subparagraph (b), sections (i) and (ii) of this article shall be borne by the requesting Party or Parties, except where the Council concludes on the basis of the report on the special inspection that, in view of the circumstances existing in the case, such costs and expenses should be borne by the Agency.

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3. The General Conference shall formulate the procedures for the organization and execution of the special inspections carried out in accordance with paragraph 1, subparagraph (b), sections (i) and (ii) of this article.

4. The Contracting Parties undertake to grant the inspectors carrying out such special inspections full and free access to all places and all information which may be necessary for the performance of their duties and which are directly and intimately connected with the suspicion of violation of this Treaty. If so requested by the authorities of the Contracting Party in whose territory the inspection is carried out, the inspectors designated by the General Conference shall be accompanied by representatives of said authorities, provided that this does not in any way delay or hinder the work of the inspectors.

5. The Council shall immediately transmit to all the Parties, through the General Secretary, a copy of any report resulting from special inspections.

6. Similarly, the Council shall send through the General Secretary to the Secretary-General of the United Nations, for transmission to the United Nations Security Council and General Assembly, and to the Council of the Organization of American States, for its information, a copy of any report resulting from any special inspection carried out in accordance with paragraph 1, subparagraph (b), sections (i) and (ii) of this article.

7. The Council may decide, or any Contracting Party may request, the convening of a special session of the General Conference for the purpose of considering the reports resulting from any special inspection. In such a case, the General Secretary shall take immediate steps to convene the special session requested.

8. The General Conference, convened in special session under this article, may make recommendations to the Contracting Parties and submit reports to the Secretary-General of the United Nations to be transmitted to the United Nations Security Council and the General Assembly.

Article 20:

1. The General Conference shall take note of all cases in which, in its opinion, any Contracting Party is not complying fully with its obligations under this Treaty and shall draw the matter to the attention of the Party concerned, making such recommendations as it deems appropriate.

2. If, in its opinion, such non-compliance constitutes a violation of this Treaty, which might endanger peace and security, the General Conference shall report thereon simultaneously to the United Nations Security Council and the

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General Assembly through the Secretary-General of the United Nations, and to the Council of the Organization of American States. The General Conference shall likewise report to the International Atomic Energy Agency for such purposes as are relevant in accordance with its Statute.

VI. Treaty on the Non-Proliferation of Nuclear Weapons (1970).[3/]

Article III:

1. Each non-nuclear-weapon State Party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agency's safeguards system, for the exclusive purpose of verification of the fulfilment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. Procedures for the safeguards required by this article shall be followed with respect to source or special fissionable material whether it is being produced, processed or used in any principal nuclear facility or is outside any such facility. The safeguards required by this article shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.

2. Each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this article.

3. The safeguards required by this article shall be implemented in a manner designed to comply with article IV of this Treaty, and to avoid hampering the economic or technological development of the Parties or international co-operation in the field of peaceful nuclear activities, including the international exchange of nuclear material and equipment for the processing, use or production of nuclear material for peaceful purposes in accordance with the provisions of this article and the principle of safeguarding set forth in the Preamble of the Treaty.

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[3/] By August 1980, 70 agreements for the application of safeguards pursuant to the NPT were in force. The text which forms the basis for all these agreements is contained in IAEA document INFCIRC/153.

4. Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this article either individually or together with other States in accordance with the Statute of the International Atomic Energy Agency. Negotiation of such agreements shall commence within 180 days from the original entry into force of this Treaty. For States depositing their instruments of ratification or accession after the 180-day period, negotiation of such agreements shall commence not later than the date of such deposit. Such agreements shall enter into force not later than 18 months after the date of initiation of negotiations.

VII. Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof (1972):

Article III:

1. In order to promote the objectives of and insure compliance with the provisions of this Treaty, each State Party to the Treaty shall have the right to verify through observation the activities of other States Parties to the Treaty on the sea-bed and the ocean floor and in the subsoil thereof beyond the zone referred to in article I, provided that observation does not interfere with such activities.

2. If after such observation reasonable doubts remain concerning the fulfilment of the obligations assumed under the Treaty, the State Party having such doubts and the State Party that is responsible for the activities giving rise to the doubts shall consult with a view to removing the doubts. If the doubts persist, the State Party having such doubts shall notify the other States Parties, and the Parties concerned shall co-operate on such further procedures for verification as may be agreed, including appropriate inspection of objects, structures, installations or other facilities that reasonably may be expected to be of a kind described in article I. The Parties in the region of the activities, including any coastal State, and any other Party so requesting, shall be entitled to participate in such consultation and co-operation. After completion of the further procedures for verification, an appropriate report shall be circulated to other Parties by the Party that initiated such procedures.

3. If the State responsible for the activities giving rise to the reasonable doubts is not identifiable by observation of the object, structure, installation or other facility, the State Party having such doubts shall notify

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and make appropriate inquiries of States Parties in the region of the activities and of any other State Party. If it is ascertained through these inquiries that a particular State Party is responsible for the activities, that State Party shall consult and co-operate with other Parties as provided in paragraph 2 of this article. If the identity of the State responsible for the activities cannot be ascertained through those inquiries, then further verification procedures, including inspection, may be undertaken by the inquiring State Party, which shall invite the participation of the Parties in the region of the activities, including any coastal State, and of any other Party desiring to co-operate.

4. If consultation and co-operation pursuant to paragraphs 2 and 3 of this article have not removed the doubts concerning the activities and there remains a serious question concerning fulfilment of the obligations assumed under this Treaty, a State Party may, in accordance with the provisions of the Charter of the United Nations, refer the matter to the Security Council, which may take action in accordance with the Charter.

5. Verification pursuant to this article may be undertaken by any State Party using its own means, or with the full or partial assistance of any other State Party, or through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

6. Verification activities pursuant to this Treaty shall not interfere with activities of other States Parties and shall be conducted with due regard for rights recognized under international law, including the freedoms of the high seas and the rights of coastal States with respect to the exploration and exploitation of their continental shelves.

VIII. Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (1972):

Article V:

The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in relation to the objective of, or in the application of the provisions of, the Convention. Consultation and co-operation pursuant to this article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

Article VI:

(1) Any State Party to this Convention which finds that any other State Party is acting in breach of obligations deriving from the provisions of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council.

(2) Each State Party to this Convention undertakes to co-operate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation.

IX. Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems (1972):

Article XII:

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.

3. Each Party undertakes not to use deliberate concealment measures which impede verification by national technical means of compliance with the provisions of this Treaty. This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices.

Article XIII, paragraph 1, provides that:

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall establish promptly a Standing Consultative Commission, within the framework of which they will, inter alia,

(a) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(b) provide on a voluntary basis such information as either Party considers necessary to assure confidence in compliance with the obligations assumed;

(c) consider questions involving unintended interference with national technical means of verification;

/...

X. Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests (1974):

Article II:

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with the generally recognized principles of international law.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.

3. To promote the objectives and implementation of the provisions of this Treaty the Parties shall, as necessary, consult with each other, make inquiries and furnish information in response to such inquiries.

XI. Treaty Between the United States of America and the Union of Soviet Socialist Republics on Underground Nuclear Explosions for Peaceful Purposes (1976):

Article IV:

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall:

(a) use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law; and

(b) provide to the other Party information and access to sites of explosions and furnish assistance in accordance with the provisions set forth in the Protocol to this Treaty.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 (a) of this article, or with the implementation of the provisions of paragraph 1 (b) of this article.

Article V:

1. To promote the objectives and implementation of the provisions of this Treaty, the Parties shall establish promptly a Joint Consultative Commission within the framework of which they will:

(a) consult with each other, make inquiries and furnish information in response to such inquiries, to assure confidence in compliance with the obligations assumed;

(b) consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous;

(c) consider questions involving unintended interference with the means for assuring compliance with the provisions of this Treaty;

(d) consider changes in technology or other new circumstances which have a bearing on the provisions of this Treaty; and

(e) consider possible amendments to provisions governing underground nuclear explosions for peaceful purposes.

2. The Parties through consultation shall establish, and may amend as appropriate, Regulations for the Joint Consultative Commission governing procedures, composition and other relevant matters.

The protocol spells out the procedures to be followed during the observation process, including such specifics as the number of observers, the geographical extent of their access, and the provision of certain information such as maps of the area of the explosion, to assist in the planning of their activities. In addition, the protocol provides for certain necessary privileges and immunities to be granted to observer personnel and their equipment, and for housing and working facilities to assure their freedom to carry out their rights and functions effectively.

XII. Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques (1977):

Article V:

1. The States Parties to this Convention undertake to consult one another and to co-operate in solving any problems which may arise in relation to the objectives of, or in the application of the provisions of, the Convention. Consultation and co-operation pursuant to this article may also be undertaken through appropriate international procedures within the framework of the United Nations and in accordance with its Charter. These international procedures may include the services of appropriate international organizations, as well as of a consultative committee of experts as provided for in paragraph 2 of this article.

2. For the purposes set forth in paragraph 1 of this article, the Depositary shall, within one month of the receipt of a request from any State Party, convene a consultative committee of experts. Any State Party may appoint an expert to this committee whose functions and rules of procedure are set out in the annex, which constitutes an integral part of this Convention. The Committee shall transmit to the Depositary a summary of its findings of fact, incorporating all views and information presented to the committee during its proceedings. The Depositary shall distribute the summary to all States Parties.

/...

3. Any State Party to this Convention which has reasons to believe that any other State Party is acting in breach of obligations deriving from the provisions of the Convention may lodge a complaint with the Security Council of the United Nations. Such a complaint should include all relevant information as well as all possible evidence supporting its validity.

4. Each State Party to this Convention undertakes to co-operate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the United Nations, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation.

5. Each State Party to this Convention undertakes to provide or support assistance, in accordance with the provisions of the Charter of the United Nations, to any Party to the Convention which so requests, if the Security Council decides that such Party has been harmed or is likely to be harmed as a result of violation of the Convention.

Annex to the Convention:

1. The Consultative Committee of Experts shall undertake to make appropriate findings of fact and provide expert views relevant to any problem raised pursuant to paragraph 1 of article V of this Convention by the State Party requesting the convening of the Committee.

2. The work of the Consultative Committee of Experts shall be organized in such a way as to permit it to perform the functions set forth in paragraph 1 of this annex. The Committee shall decide procedural questions relative to the organization of its work, where possible by consensus, but otherwise by a majority of those present and voting. There shall be no voting on matters of substance.

3. The Depositary or his representative shall serve as the Chairman of the Committee.

4. Each expert may be assisted at meetings by one or more advisers.

5. Each expert shall have the right, through the Chairman, to request from States, and from international organizations, such information and assistance as the expert considers desirable for the accomplishment of the Committee's work.

## Annex VI

## Reference Material used in preparation of Chapter Three

References

1. "On the establishment of an international satellite monitoring agency", French document, SMA/WP/3, 11 June 1979.

2. "Contribution to the technical study concerning An International Satellite Monitoring Agency", French document SMA/WP/10, 12 May 1980.

3. Report from the 34th Pugwash Symposium on "An International Agency for the Use of Satellite Observation Data for Security Purposes", 14-17 April 1980, Avignon, France.

4. Tsipis, K. "Technical, operational and policy considerations and alternatives for the use of satellite observation data for security purposes", 34th Pugwash Symposium, 14-17 April 1980, Avignon, France.

5. "Prospects for an international satellite monitoring agency", Perry, R., 27 May 1980. A paper submitted to the United Nations Expert Group on ISMA.

6. "Utilization of satellite remote sensing in Natural Resources Exploration", Natural Resources and Energy. A United Nations Report No. 2, 1979.

7. "Implementation requirements for a remote sensing training facility at an international regional data storage and dissemination centre", United Nations document A/AC.105/138, 14 January 1975.

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**Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space**

Vienna, 9-21 August 1982

# DRAFT REPORT OF THE CONFERENCE

## PREFACE

The General Assembly, in resolution 34/67, endorsed the recommendation of the Preparatory Committee for the Conference (A/34/20, para. 101) that the Secretary-General of the Conference should prepare the first draft of the final report, based on an outline to be drawn up by the Preparatory Committee. It further recommended that the Advisory Committee to the Prepratory Committee should consider this first draft early in 1982 and give its advice thereon to the Secretary-General of the Conference. Bearing in mind the advice given, the Secretary-General should prepare a second draft for the consideration of the Preparatory Committee at its last session before the Conference. The resolution also required that the draft report of the Conference, as considered and revised by the Preparatory Committee, should be circulated to Member States at least 90 days before the opening of the Conference.

The General Assembly, in resolution 36/36, endorsed the recommendations of the Preparatory Committee (A/36/46, para. 10) concerning the outline of the draft report of the Conference (ibid., annex IV). In accordance with these recommendations the draft report will consist of two parts, part one presenting the observations, conclusions and recommendations of the Conference, and part two presenting the background, organization and proceedings of the Conference.

In accordance with the above, the Secretary-General of the Conference prepared the first draft of the Conference report in December 1981 (A/CONF.101/PC/L.17 and Add.1-4). It was based on an analysis and synthesis of views expressed and recommendations made in the national papers submitted by Member States, background papers prepared for the Conference, recommendations of the regional seminars held in conjunction with the Conference and discussions in the Preparatory Committee and the General Assembly.

The Advisory Committee, at its third session held in January 1982, considered the draft section by section through an open-ended working group under the chairmanship of Mr. Carlos Antonio Bettencourt Bueno (Brazil) and requested the Secretary-General of the Conference to revise the draft report of the Conference for the consideration of the Preparatory Committee, taking into account the comments and observations made in the Advisory Commitee (A/CONF.101/PC/6, paras. 5-12).

The Secretary-General of the Conference revised the draft report on the basis of comments and observations made in the Advisory Committee as well as a considerable amount of detailed comments received from the specialized agencies and other organizations and departments of the United Nations. The revised draft report of the Conference was submitted in document A/CONF.101/PC/L.20 and Add.1, Add.1/Corr.1 (English only) and Add.2.

The Preparatory Committee, at its fourth session held in March/April 1982, considered and revised the draft almost on a paragraph-by-paragraph basis through an open-ended working group also chaired by Mr. Bueno (Brazil).

During the course of its consideration, several proposals and amendments were introduced by members of the Preparatory Committee, many of which were agreed upon. Where there was disagreement, the Preparatory Committee decided to place the original text in square brackets and, immediately following, to place the amendment(s) concerned also in square brackets. The Preparatory Committee agreed that an annex to the report should indicate the names of countries which proposed these amendments with an explanatory note on their status (see annex II). In accordance with a recommendation of the Preparatory Committee, an index to conclusions and recomendations of the Conference in the draft report is provided in an annex to the report (annex I), solely for the information and guidance of the Conference participants. The Preparatory Committee also recommended that the draft report be accompanied by a statement of financial implications which is being issued as an addendum to the present report (A/CONF.101/3/Add.1).

In accordance with the recommendation of the General Assembly, the draft final report of the Conference, as considered and revised by the Preparatory Committee, as contained in this document, is being circulated to Member States 90 days before the opening of the Conference.

At the Conference, the three substantive chapters will be referred to and considered by the three Main Committees of the Conference, respectively. The three Committees will submit their reports to the Conference in plenary meeting for adoption. The final report of the Conference, as adopted by it in plenary meeting, will be submitted, in accordance with General Assembly resolution 36/36, paragraph 9, for consideration by the General Assembly at its thirty-seventh session.

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACC | Administrative Committee on Co-ordination (United Nations) |
| AFROSAT | African regional communications satellite |
| APT | automatic picture transmission |
| ARABSAT | Arab Satellite Communications Organization |
| ASEAN | Association of South-East Asian Nations |
| BSS | Broadcasting Satellite Service |
| CCIR | International Radio Consultative Committee (ITU) |
| CCITT | International Telegraph and Telephone Consultative Committee (ITU) |
| CCT | computer compatible tape |
| CFC | chlorofluorocarbon |
| CNES | Centre national d'études spatiales (France) |
| COPUOS | Committee on the Peaceful Uses of Outer Space (United Nations) |
| COSPAR | Committee on Space Research (ICSU) |
| DBS | direct broadcast satellite |
| DCP | data collection platform |
| ECS | European Communications Satellite |
| EIRP | equivalent isotropically radiated power |
| ELDO | European Space Vehicle Launcher Development Organization |
| ESA | European Space Agency |
| ESRO | European Space Research Organization |
| EUTELSAT | European Telecommunications Satellite Organization |
| FAO | Food and Agriculture Organization of the United Nations |
| FES | fluid experiment system (SPACELAB) |
| FGGE | First GARP Global Experiment (WMO) |

| | |
|---|---|
| FPM | fluid physics module (SPACELAB) |
| GARP | Global Atmospheric Research Programme |
| GEMS | Global Environment Monitoring System |
| GPS | Global Positioning System |
| GSO | geostationary orbit |
| HDDT | high density digital tape |
| IAF | International Astronautical Federation |
| ICAO | International Civil Aviation Organization |
| ICSU | International Council of Scientific Unions |
| IFRB | International Frequency Registration Board (ITU) |
| IGCP | International Geological Correlation Programme |
| IGOSS | Integrated Global Ocean Services System |
| IHP | International Hydrological Programme (WMO) |
| IMCO | Inter-Governmental Maritime Consultative Organization |
| IPDC | International Programme for the Development of Communication |
| INMARSAT | International Maritime Satellite Telecommunications Organization |
| INTELSAT | International Telecommunications Satellite Organization |
| INTERCOSMOS | Programme on International Co-operation in the Study and Peaceful Utilization of Outer Space |
| INTERSPUTNIK | International System and Organization of Space Communications |
| IOC | Intergovernmental Oceanographic Commission (UNESCO) |
| ITU | International Telecommunication Union |
| MAB | Man and the Biosphere |
| MONEX | Monsoon Experiment (WMO) |
| NASA | National Aeronautics and Space Administration (United States) |
| NNSS | Navy Navigation Satellite System (United States) |

| | |
|---|---|
| NPS | nuclear power source |
| RF | radio frequency |
| SARSAT | search and rescue satellite aided tracking |
| SETI | search for extraterrestrial intelligence |
| SITE | Satellite Instructional Television Experiment (India) |
| SPS | solar power satellite |
| SSTO | single stage to orbit |
| UNCSTD | United Nations Conference on Science and Technology for Development |
| UNDP | United Nations Development Programme |
| UNDRRO | Office of the United Nations Disaster Relief Co-ordinator |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| VLBI | very long baseline interferometry |
| WARC | World Administrative Radio Conference |
| WEFAX | weather facsimile |
| WMO | World Meteorological Organization |
| WWW | World Weather Watch (WMO-ICSU) |

## INTRODUCTION

1. Space has always had a special fascination for man, ever since the first intelligent being looked up into the sky. Man worshipped the Sun as the life-giver even before science had shown it to be so, and the Moon has had an aura of romance around it for centuries. In our collective psyche, space has always meant freedom, romance, the challenging unknown - and "heaven".

2. Now, after millennia of looking upward and outward from the Earth, man has acquired the ability to do the reverse also: to look at our home planet from a vantage point in space. What we see is immensely beautiful and very revealing: a lonely, shimmering sphere, abundant in resources, solid and yet very fragile; a planet whose life processes are inextricably interdependent, where life depends upon the delicate and unique balance between man and nature, between man and man. What is not visible is equally revealing: we cannot discern different countries or separate peoples. Space has given us a new perspective on the universe, our solar system and our own planet. Can it also give us a new perspective on ourselves?

3. We are now also able to look out - to other planets, other stars and other galaxies - without having our vision clouded by the haze of the atmosphere, thus allowing us to see farther out and back almost to the beginning of the universe. This has helped to confirm increasingly the theory that the universe evolved from a single fireball of energy some 15 billion years ago and that the material which formed our earth and solar system was synthesised in the evolution and explosion of an earlier star, demonstrating our common ancestry and innate unity - not only with each other, but indeed with all things in the universe.

4. Apart from the philosophical and ethical implications of the view from space, there are also immense immediate benefits. Communication satellites have virtually revolutionized telecommunications and broadcasting, while earth-observation spacecraft provide meteorological data of great importance and have considerable potential for contributing to resource management systems through remote sensing. Spacecraft are also replacing celestial bodies in space as means for accurate position-location and for navigation. Long-term benefits of our capability to send objects - and people - into space include not only applications in these fields, but also in biology, medicine, materials and, possibly, energy. Generation of new knowledge and understanding is not only a benefit, but a fulfilment of human destiny.

5. The rapid growth of space technology and its potential for important applications was already clear in the 1960s and led to the convening in Vienna in 1968 of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. The Conference stimulated a great deal of interest - in both developed and developing nations - in space and its applications.

6. It is now almost a decade and a half since the 1968 Vienna Conference and in this period there have been great strides in space science, technology and applications. These revolutionary developments, this new dimension to which man has now acquired access, have been made possible by the very rapid advances

in a number of interconnected discipline . Within the space of one generation, these advances have led from the launch of the first artificial satellite in 1957 to manned spaceflight, men and robot vehicles on the Moon, automatic landers on Mars and Venus, missions past Jupiter and Saturn, to the first partially reusable launch vehicle and space stations in earth orbit. Of more direct relevance, we have witnessed the establishment and now routine operation of space communication systems, both international and domestic, of space broadcasting systems, of a global observation system for meteorology, of operational navigation and maritime communication systems and of quasi-operational remote-sensing systems. About 150 countries now use space communication and more than 220 stations for the direct reception of image data from meteorological satellites are in operation around the world. It is estimated that over 100 countries have by now used data from remote sensing satellites and almost 40 countries have already joined the only recently formed International Maritime Satellite Organization (INMARSAT). While only two satellites were launched in 1957, the beginning of the space era, an average of some 120 satellites are now launched annually. Such a high level of space activity and the many diverse systems clearly require a degree of international co-operation, co-ordination and regulation. While bilateral and multilateral activities have promoted this, an important role has been played by the United Nations and its specialized agencies. The progressive development of the law of outer space including, in particular, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies and the work done by the International Telecommunication Union in the field of radio regulations concerning outer space, have created conditions conducive to the smooth and orderly growth of space activities.

7. At the same time, the increasing use of space - for scientific purposes, experimentation and applications - and the growth of space technology, necessitate a fresh look at possibilities, potentials and implications. In particular, while the first outer space Conference did a great deal to promote awareness of the immense promise of space, it is now time to proceed further and take appropriate measures for the wider and fuller utilization of space technology. In doing this, there is a special need to examine how the United Nations system can play a more effective role in stimulating the peaceful uses of outer space so as to benefit all nations - including especially the developing ones - and how the United Nations can promote and co-ordinate international efforts to this end. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space was convened to allow wider participation of Member States in the activities of the United Nations in outer space matters and to assess the new developments, to exchange information and experiences on their present and potential impact, and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology.

8. Space science and technology cannot be considered in isolation, but must be seen as an integral part of the totality of science and technology, which in turn form part of the social, industrial, educational and cultural context of human society. The role of science and technology in society and in the pro-

cess of economic and social development was the subject of the United Nations Conference on Science and Technology for Development (UNCSTD) held in Vienna in August 1979. The conclusions of the Conference are, in general, applicable to the field of space science and technology. It might be useful to recall here a few of the observations contained in the UNCSTD report that are particularly relevant:

(a) Developed countries continue to dominate the field of science and technology to the extent that around 95 per cent of all research and development is executed by them, while developing countries, which represent 70 per cent of the population of the world, have only about 5 per cent of the world's research and development capacity. These figures demonstrate the magnitude of the problem and the task facing the international community.

(b) The necessary resources and technological potentials exist for eliminating the underdevelopment of the developing countries and for improving the well-being of humanity as a whole. The achievement of this goal presupposes that developing countries exercise full control over their own resources. It also presupposes an equitable distribution and creation of scientific and technological capabilities of the world.

(c) The industrialized countries have, through their control of science and technology, provided themselves with an immense power to enhance the human environment, increase production and improve the standard of living of their population. However, their production and consumption patterns have led to a waste of resources and often carried with them negative social and environmental consequences. To avoid such undesirable effects, developing countries should carefully analyse the options in connexion with the choice, development and transfer of technology.

(d) The ultimate goal of science and technology is to serve national development and to improve the well-being of humanity as a whole. Men and women in all groups of society can contribute positively to enhance the impact of science and technology on the development process. However, modern technological developments do not automatically benefit all groups of society equally. Such developments, depending on the given economic, social and cultural context in which they take place, are often seen to affect various groups in society differently.

[(e) The primary responsibility for the development of developing countries rests upon these countries themselves. The developing countries are committed to assuming their responsibility, individually and collectively, through economic, scientific and collective self-reliance. However, effective action at the international level, especially by developed countries, is required to create an environment that is fully supportive of the national effort of the developing countries to realize their development goals.]

[(f) International development co-operation in the field of science and technology must assist developing counries in strengthening their creative and innovative capacity and thereby promote their autonomous scientific and technological capacity.]

9. These observations and the more detailed considerations and conclusions that are contained in the report of UNCSTD served as an important backdrop for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82).

10. The present report, reflecting the considerations and conclusions of UNISPACE 82, is divided into three chapters. Following the introduction, the next part (chap. I) assesses the present and likely future state of space science and technology. The following part (chap. II) discusses present and potential applications of space science and technology, their implications, and the means of ensuring that all countries derive benefits from space. It also examines the choices for countries with regard to space technologies and the difficulties faced in using it. The important issues about the use of the geostationary orbit and access to space technology are discussed, as are matters connected with the compatibility and complementarity of systems and the protection of the environment. Chapter III deals with international co-operation and the role of the United Nations, including especially co-operation between developing countries. It makes recommendations with regard to the future role of the United Nations and financing. An annex to the report serves as an index to the recommendations and conclusions contained in the three preceding chapters. In accordance with the agenda, the Conference was not limited to discussions on science and technology, but also considered their relevance to man and his environment. The Conference discussed scientific, technological, social, economic, organizational and other relevant aspects and their interrelationship.

11. The growing range of space applications has brought benefits to many countries. While most developing countries use space technology, they have not yet fully exploited its considerable potential and their use has been limited, in most cases, to only a small part of their activities (e.g. only for overseas communication). [Space technology is by no means the complete solution to a country's problems and neither can there be any generalized prescriptions for the use of space technology. However, it is often a more effective alternative for achieving a given goal, and can sometimes bring about a qualitative change by doing things not possible through more conventional means.] [In fact, only the developed countries with advanced technology can fully exploit these benefits. This state of unevenness is unfair and unreasonable. The international community should make common efforts to bring about a gradual change in the present situation. To this end, the developed countries with advanced technology, particularly the super space Powers, should assume greater responsibilities.] Space technology can be a powerful tool to accelerate national development: it provides a way of leap-frogging over obsolete technologies and getting away from percolation and trickle-down models of development for which developing countries do not have the time. It could effectively deal with the problems of illiteracy, isolation and lack of information afflicting the development process. Depending upon each country's unique social, economic, cultural and resource context, and taking account of other alternative technologies, space could play an important role in specific areas of development.

It is therefore necessary that all countries be able to have access to space technology. Knowledge should not be constrained by artificial boundaries, and rapid and widespread dissemination of knowledge and sharing of technology in this field can greatly promote the process of development. Space is our collective environment and its use for human benefit should be through the participation and partnership of all peoples.

12. [At the same time, it is obvious that the future of developing countries depends primarily upon themselves, that the responsibility for their development lies with them. This implies effort, self-reliance, motivation and mobilization. Space technology is not a magic wand that can bring sudden wealth, but - wisely applied - it does have the potential to spur economic development and, equally important, bring about greater equity through education and social change.]

[Replace whole para by: Space technology offers the potential to spur economic and social development of all countries. In this connexion, international co-operation should be seen and conceived as a major instrument in assisting all countries, especially developing countries, to derive the optimum benefits from the application of space technology.]

13. [A major concern, a barrier to greater co-operation and a potential obstacle to deriving the full benefits of space technology, is the increasing militarization of space. Some military activities - e.g., national technical means of verification (surveillance satellites), navigation aids, comunications for search and rescue, dissemination of meteorological data, etc. - have continued for many years and some have been used for civilian purposes also. However, the recent introduction and proposed development of aggressive systems in space have cast a dark shadow over the peaceful and beneficial uses of space. In order for the peaceful uses of space to develop in a co-operative, constructive and unhindered manner, it is necessary to forestall and reverse this unfortunate trend towards the increased militarzation of space.]

[Insert at the end of first sentence: and the real threat to mankind's peace which the arms race in space constitutes.]

[At the end of last sentence add: put an end to the arms race and take steps to demilitarize outer space, the common heritage of mankind.]

[Replace first sentence by: The increasing militarization of space constitutes a barrier to the attainment of better co-operation and an obstacle to obtaining all the benefits of space technology]

[Replace full para by: A major concern, a barrier to greater co-operation and a potential obstacle to deriving the full benefits of space technology, is the militarization of outer space, which represents a danger to international peace and security. In addition to satellites specifically built for military purposes (surveillance, military communication and navigation), the satellites intended for other, non-military purposes (earth resources, meteorology, etc.) are also used for military needs. Moreover, the recent introduction and proposed development of aggresive systems in space continue to cast a dark shadow over the peaceful and beneficial uses of space. In order for the peaceful uses of space to develop in a co-operative, constructive and unhindered manner, it is necessary to forestall and reverse this unfortunate trend towards the increased militarization of space and take measures for demilitarization of space, the common heritage of mankind.]

14. Space technology has made dramatic progress in our own lifetime. It has changed our concept of distance, made each person the neighbour of all others and given us a new measure of ourselves in relation to the cosmos. Can we now rid ourselves of our obsolescent biases and concepts, and move forward to the more equitable, humane and co-operative society that the image from space conjures up?

## I. STATE OF SPACE SCIENCE AND TECHNOLOGY

15. Since the launch of the first artificial earth satellite (1957), and in particular since the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (1968), space science and technology have developed extremely rapidly. Satellites, first used for space research, were soon used for experimental applications as well. Within a decade of the launch of the first satellite, operational space systems were established for telecommunications and meteorology. Today, telecommunications, television broadcasting, meteorology, maritime communication, navigation, geodesy and remote sensing routinely make use of satellites.

16. This extensive use of space for a variety of applications has been brought about by the immense progress in space technology. Today, it is possible to launch a payload weighing tens of tons into low earth orbit - compared with the tens or hundreds of kilograms that the early rockets could launch. Many developments, particularly improvements in reliability, in micro-electronics, in materials, in solar cell technology and deployment mechanisms, have revolutionized space technology. Man has not only gone into space, he has also stepped on the moon. Equally impressive missions have been carried out by completely automated spacecraft, responding to commands and relaying data from millions of kilometres away.

17. Space science has made equally astounding progress and in many cases has been the cause of technological developments. It has brought new understanding about the solar system and indeed about the whole universe. Unexpected discoveries have shed new light on the origin of the solar system and of the universe itself. Closer to earth, space science has vastly improved the understanding of the atmosphere and climate and has led to better weather prediction. Space biology and medicine are completely new fields that may help solve medical problems. Materials science experiments in space should result in the production of better, possibly cheaper and new materials.

18. The present chapter briefly reviews some of the exciting developments in these fields of space science and technology, and makes a few suggestions for future action.

### A. Space science

19. The oldest space science is, of course, astronomy. Its birth probably dates back to the time when the first intelligent being looked up at the beauty of the star-studded sky. The arrival of the space age allowed Man the possibility of observing the universe from outside the Earth's atmosphere. For looking at the planets, the sun, the stars, our galaxy and other objects extending into the deep depths of space (and billions of years backwards in time), this was like removing blinkers from his eyes. The maximum emission of the Sun's energy occurs in the same narrow band of wavelengths in the optical region of the electromagnetic spectrum to which the Earth's atmosphere is transparent; it is no accident that the range of sensitivity of our eyes

is also confined to precisely these wavelengths. Even in this narrow band of wavelengths, our ability to distinguish between various objects is greatly enhanced because we have the faculty of separating different colours (i.e. by different responses to different wavelengths). Outside the atmosphere the extraterrestrial signals cover a wavelength range millions of times larger than the optical band. An ability to detect those signals and analyse them can, therefore, provide an enormous amount of new information about the nature of astrophysical phenomena. Indeed, every time a new window for astrophysical observations is opened, we find a few things which had never been expected by the most imaginative of scientists, even though practically everything we do find can be ultimately understood in terms of the physics we learn here on Earth. One such window was opened by the discovery of radio- astronomy in the 1940s. This did not have to await the arrival of the space era, since radio waves at wavelengths between a few centimetres and several hundred metres are not significantly attenuated by the Earth's atmosphere or by the ionosphere. It was soon found that not only does our Sun emit radio waves, but there are a large number of sources - compact and diffuse - in the universe which emit a significant fraction of their energy in radio. By building larger and more sensitive instruments and inventing auxiliary observational techniques, man's radio-visibility was extended to much further distances than was possible through observations with optical telescopes.

20. But for the techniques of radio astronomy, we would forever be ignorant about a great many phenomena in the universe. Amongst them are the cosmic background of black-body radiation representing, most probably, the cooled down remnant of the hot fireball associated with the "birth" of the universe some 15 billion years ago, and the existence of a host of organic molecules in interstellar space. Different happenings and things in the universe can speak at different frequencies and unless we tune in, we will not be able to put the pieces of the picture together.

21. Observations in the ultraviolet, X-ray and gamma ray wavelengths are possible only from the top of the atmosphere, using balloons, rockets and especially satellites. These observations have led to some of the most remarkable advances in astronomy in the last 20 years. Some of the new understanding relates to the high temperature and dynamical phenomena on the Sun. That the Sun has a high temperature corona was directly verified through the observation of soft X-rays. X-ray and ultraviolet observations have shown similar and more extensive coronal features around other stars. Like the sun, most stars have stellar winds, and a great deal of the stellar surface material is continuously cast out into space, often in great bursts.

22. About a thousand X-ray sources have been observed since the almost accidental discovery of X-ray sources during a rocket flight. X-rays are emitted from galaxies, quasars, diffuse envelopes and remnants of supernova explosions, compact objects such as neutron stars - alone or in close-binary systems - and by hot intergalactic matter. Some of the objects emit 10,000 times as much energy in X-rays as the total energy output of the Sun. A picture begins to emerge, with crucial support from X-ray observations from space, that compact objects and close binary systems are fairly abundant in the universe.

The discovery and analysis of the X-ray pulsar phenomena form one of the most exciting chapters in modern astronomical history.

23. Gamma rays are simply X-rays of much shorter wavelength or higher energy per quantum. Gamma ray emission has been observed from supernova remnants, some pulsars, and from the disc of the galaxy. Since high energy (most probable energy about 100 MeV) gamma rays can be produced in interactions of high energy cosmic-ray particles with matter, they provide a powerful tool for surveying matter density and cosmic rays in interstellar space. Positive and negative electrons can annihilate each other in slow collisions, resulting in gamma rays of energy close to 0.5 MeV. Such a gamma ray line has been observed towards the centre of our galaxy. Intense bursts of X-rays and gamma rays from some objects (so called "bursters") have challenged the understanding of astrophysicists.

24. Observational evidence for the existence of compact, dense objects like neutron stars on the one hand and possible existence of an early hot dense state of the universe on the other, is beginning to provide new insights and constraints on our ideas about the basic structure of matter and the relation between fundamental forces of nature. In this sense many of the observations in astronomy simultaneously impact our understanding of sub-nuclear physics and cosmology.

25. Immediately on the longer wavelength side of the visible spectrum lies a long band of infra-red wavelength extending from 1 micrometre (um) to about 100 um. The earth's atmosphere allows specific narrow parts of the near infra-red spectrum to pass through without significant attenuation. During the last couple of decades many surprising discoveries have been made with ground-based telescopes. Many objects are found to emit significantly large amounts of energy in the infra-red wavelengths. Longer wavelengths (> 20 um) have been accessible only through balloon and rocket observations. Many cool stars and clouds have been discovered and studied. When infra-red telescopes are deployed in space, many new aspects of the galaxy and the universe will reveal themselves for the first time. Particularly interesting is the possibility of observing the slowly contracting clouds of material on their way to becoming stars like our Sun.

26. Balloon and ground-based observations during the last 30 years or more have already established that cosmic rays consist primarily of atomic nuclei, extending from hydrogen to uranium, accelerated to extremely high energies. The energy spectrum ranges over many orders of magnitude and the highest energies are far beyond any values we can hope to achieve in our accelerator laboratories. The relative abundance of different elements and the spectrum at low energies have been established by many clever experiments aboard satellites. Lower down in the atmosphere the cosmic ray nuclei break up in nuclear interactions with air nuclei and many new species of short-lived and stable particles are produced, some of which propagate deep into the earth. Precise elemental and isotopic composition of cosmic rays, as also their energy spectrum, carries very significant information about the sources, the acceleration mechanism and the propagation of this radiation. Some of the most important parts of this information can be obtained only through space observations. This

cosmic ray signal is valuable because it is the only form of particulate matter which comes to us from the depths of space, carrying with it the signature of rather unique cataclysmic events in which it is produced and accelerated, as also the scars of its encounters with intervening matter and radiation.

27. Space astronomy, as discussed in the previous paragraphs, is but a form of very remote "remote sensing". Space capabilities also allow us the possibility of going close to some of the objects and phenomena and studying these at near range or in situ. This is at present possible only for the region of the galaxy confined to our own solar system, since a return voyage to even the nearest star seems at present impractical in terms of both cost and elapsed time.

28. The study of the solar system, particularly the motions of the planets, was perhaps the first "science" that preoccupied man. The order and predictability of the planetary motions pointed strongly to the existence of a natural law and finally resulted in the founding, by Kepler, Galileo and Newton, of the first and most basic branch of physics, namely, dynamics and universal gravitation. It is no wonder, therefore, that soon after the dawn of the space age, a visit to the Moon and the near planets of the solar system was put high on the agenda. Modern space observations have been used to study - besides the Sun - Mercury, Venus, Earth, Moon, Mars, Jupiter, Saturn and the four Jovian satellites. For obvious reasons, the most intensive studies have been concentrated on the Earth and its environment.

29. Man has landed on the Moon and several hundred kilograms of lunar material have been brought back to the Earth, both by manned missions of the United States and unmanned robots of the Soviet Union. A study of this material by hundreds of scientists around the world has provided new and valuable information about the chemical composition, structure, and evolution of the Moon: the history of the cratering process, size distribution of micro-meteorites and the prehistory of low energy cosmic rays and the solar wind. The instruments left on the Moon have continued to give data on the heat outflow and moon-quakes, rare though they are. There is no evidence of current volcanic activity. By now we know more about the Moon than about any other planet in the solar system, except Earth.

30. Besides the Moon, Man has been able to land instruments only on two other planets, namely, Venus and Mars. Several landers on Venus provided atmospheric and soil analyses and transmission of panoramic pictures of the surface. Venus was and remains very interesting because, in terms of size and distance from the Sun, it is the planet most similar to Earth. On the other hand, its atmosphere is principally carbon dioxide with considerable traces of noble gases, with a pressure 100 times greater than the atmospheric pressure on the Earth. The surface temperature is about 470°C. There is indication of fairly active geological history, with volcanoes and craters still discernible. One of the most interesting findings is that Venus and Mars both lack any measurable intrinsic magnetic fields. This places severe constraints on any theories to account for the intrinsic magnetic field of the Earth.

31. Mars has always been an intriguing planet because of early speculation about the possible existence of life on it. It has been studied by several space missions, including a lander, which provided spectacular photographs of the surface and analysed the soil for its chemical composition and evidence of biological activity. The atmosphere of Mars is rather thin (about 0.6 per cent of the Earth's atmospheric pressure) and, as on Venus, consists mainly of carbon dioxide with 1 to 2 per cent of nitrogen and argon. There is no indication of any biological activity, though surface features suggest running water and catastrophic floods some time in the past.

32. Mercury has not been studied very intensively, though a most significant discovery by the very first fly-past mission was that of a weak intrinsic magnetic field. Mercury is very hot on the sunlit side and very cold on the other. The surface is heavily cratered like the Moon, and it is too small and close to the Sun to have an atmosphere.

33. Of the giant planets (Jupiter, Saturn and Uranus), Jupiter and Saturn have already been observed by planetary probes. Jupiter is the largest planet in the solar system, with a mass greater than that of all the others put together. Like the other two giants, Jupiter is really a proto-planet, in the sense that it is in the same state as it was when formed 4.3 thousand million years ago and has not lost its lighter elements or noble gases. Thus the most abundant elements are hydrogen and helium and there is no solid crust like the one on the terrestrial planets. Its atmosphere is about 1000 kilometres thick, and, besides the above two gases, contains methane and ammonia. The atmospheric phenomena are grand and have been observed in some detail by visiting spacecraft. Winds up to 400km/h have been observed. The atmosphere has a large scale banded structure caused by the effect of rapid rotation of the planet (about 10 hours) on the upward convection currents. In addition, there is an endless variety of eddies or turbulence caused by high winds, the most prominent of which is the famous Great Red Spot, which has varied somewhat during the 300 years it has been observed. The formation and persistence of this great storm is still not properly understood.

34. Jupiter emits about twice as much energy as it receives from the Sun, and, indeed, can be considered a micro-star. It has a strong magnetic field, about 10 times the Earth's value, at its surface. Jovian magnetospheric phenomena have been studied in great detail by various fly-by missions. Particles are accelerated and produce radio waves in interaction with the magnetic field. In fact Jupiter is the strongest radio source in the sky.

35. The largest four satellites of Jupiter were discovered by Galileo, in the earliest observation of the heavens by a telescope. Of these, two are about the size of the planet Mercury, and the other two the same size as the Moon. By now the number discovered has increased to 16, including those seen by spacecraft. Thus Jupiter as a minor solar system represents an excellent astronomical laboratory. Some of the satellites have been studied by the Voyager spacecraft and have revealed interesting and differing features. One of these, Io, though only the size of the Moon, has been found to be the most volcanic object in the solar system. It is believed that Io is an important source of the plasma that

populate the magnetosphere of Jupiter, and of the radio-emission therefrom. It is probably because of the influence of Io that the radio emission of the planet shows a 10-hour variation, a period which is the same as the rotation period of the planet. In this sense Jupiter is also a "pulsar", the nearest one to home.

36. Saturn has many properties in common with Jupiter as one of the giant planets. A most interesting feature of this planet is its spectacular rings. These have been studied in fair detail by the two Voyager spacecraft and have revealed many new features. The role of small moons in the evolution of the ring structure is beginning to be understood. Many of the newly discovered radial features are yet to be explained properly.

37. The discovery of radiation belts by Explorer-I and the detection of the solar wind by Lunik-2 initiated a new and active field of research in solar terrestrial relationships. Radiation belts are produced by a large population of low-energy charged particles trapped in the earth's magnetic field. These are found to cause geomagnetic disturbances and provide the excitation mechanisms for auroral emissions at high latitude. Most of the particles in the belt are captured from the solar wind, though some are accelerated within the belt. Particles precipitating in the auroral regions are also the source of strong radio emissions from the earth.

38. The sun interacts with the earth not only through its light and heat, but also through emission of some of its material in the form of ions and electrons, which impinge on top of the magnetosphere of the earth. This stream of plasma, called the solar wind, varies in temperature, intensity and speed. The plasma also carries along a magnetic field, essentially stretched out from the sun to fill the interplanetary space. The solar wind is the source of the bulk of the particles in the radiation belts. Interaction of the solar wind with the magnetosphere produces a magneto-pause on the sunlit side and stretches out the earth's magnetic field into a long tail on the opposite side. Like in the case of the earth, the solar wind is the root cause of the formation of the magnetospheres of other planets also.

39. Space observations have unravelled many of the features of this complicated interaction, though several aspects are still not well understood. In situ measurements of the solar wind and magnetic fields have been made by several space missions, but all these are confined to regions of interplanetary space close to the ecliptic. The out-of-ecliptic missions planned for the near future will add significantly to our understanding of interplanetary phenomena.

40. Study of solar-terrestrial phenomena is important in its own right because a great deal of distant and inaccessible astrophysical phenomena must be of a similar nature. A wide range of solar-terrestrial variations can also produce effects on a number of practically significant areas such as communication, transport, power and energy, space systems, navigation and, perhaps, weather and climate. Winds and storms that rage in the plasmas and magnetic fields existing from the top of our atmosphere to the solar surface have

effects on man which in their own right can be as potentially hazardous as the atmospheric storms which sweep across the earth's surface.

41. Space science and space scientists have provided the cutting edge of developments in space technology. Discoveries in science are not made only through design of instruments or observation. Equally important is the work of the theoretical scientists who work at producing coherent systems out of the mass of data and suggest further experiments. But without the capability to observe, there is no stimulation and no proof. And very seldom does man have an imagination as rich as nature itself displays. Observations are, therefore, essential.

42. In a short span of 25 years, our picture of the universe has been transformed because of the new observations made in the space era. However, what has been done so far is mere reconnaissance, and the real observational phase is yet to begin. Many surprises and many discoveries lie ahead awaiting the time when more or less permanent space observatories are established. In addition there will be a continuous need to have autonomous experiments for following specific leads. Space science should, therefore, continue to have a high priority; in fact, in view of its promising future, it is desirable that support be substantially increased.

43. In the case of space science missions a healthy tradition of co-operation has been established over the years, allowing experimental payloads from scientists in different countries to be put on spacecraft launched by other countries. Many co-operative experiments have been done by scientists of various countries using balloons, rockets and satellites. In more recent years, international crews - from both the developed and developing countries - have been provided opportunities for participating in experiments on orbital space stations. It is desirable that such co-operation continue and be further encouraged. Major space observatories to be set up in the future should also be open to scientists and experimenters from all countries, continuing the tradition of scientific co-operation and "quest observers" in many existing earth-based observatories. Scientists from all countries should be encouraged to use these facilities.

44. It is sometimes argued that basic science in general, and space science in particular, are not important in a world pressed by practical problems. This may not be correct. Besides the fundamental argument that an understanding of the universe we live in is important in its own right, it is also true that initiatives in space applications have most often been taken by people who were earlier motivated by their interest in space science. The encouragement of space science and space astronomy in the universities and institutions of developing countries could, therefore, provide an important stimulus and strong support to the development and practical applications of space technology.

45. This brief survey obviously cannot cover adequately the vast and growing field of space science. While aspects related to space biology and medicine and to materials science in space are discussed in the following section, a slightly more detailed exposition can be found in Conference background paper (A/CONF.101/BP/1).

## B. Experiments in space environment

46. Space provides an environment that cannot easily be reproduced on Earth: a virtual absence of gravity (micro-gravity), access to that part of the cosmic spectrum of radiations which cannot be sampled and studied on Earth and a virtually infinite source of near-vacuum. On Earth, all materials and organisms are subject to the force of gravity. The flow of liquids, the convection of fluids, the growth of plants and animals and the physiology of people are all determined or strongly influenced by gravity. Therefore, space provides a unique opportunity for studying the effects of micro-gravity and/or vacuum on life processes, man and materials.

47. There are many well-known effects of gravity in fluid systems including buoyancy, convection, sedimentation and segregation. One important phenomenon is gravity-driven convection currents in fluids, which are, in most cases, oscillatory or turbulent. In a micro-gravity environment, the relative importance of convection, diffusion and surface forces may be changed drastically. In space, crucible-free zone-melting of single crystalline materials or metals is possible without restriction by gravity effects.

48. Materials science experiments in a space environment, coupled with ground-based research, should lead to a new understanding of the basic processes. Fluid physics, chemistry, metallurgy (including composite materials and glasses), single crystals and pharmaceuticals represent specific areas of activity.

49. Single crystal growth studies require furnaces with precision temperature measurements. Such monocrystals, which are very important semiconductor material, have been grown in numerous experiments both aboard the US Skylab as well as under the USSR and the INTERCOSMOS manned space programmes aboard Salyut-6. Study of melting and solidification processes and tests of electron-beam welding in space were carried out by the USSR as early as 1969 using the "VULKAN" unit on SOYUZ-6. Apollo 14, 16, and 17 carried several small micro-gravity experiments including composite casting, electrophoresis and fluid transfer in preparation for similar larger experiments aboard Skylab. Micro-gravity experiments were also carried out during the joint Apollo-Soyuz Test Project. A few countries have also flown miniature space processing laboratories on board high-altitude rockets, which can provide a few minutes of microgravity conditions. Limited experiments have been conducted using aircraft trajectories and drop towers, providing respectively up to one minute and a few seconds of simulated microgravity conditions. It is likely that not too far in the future, semiconductor materials which are difficult and expensive to produce on earth with the degree of purity and perfection required by modern electronic and microelectronic industry will be manufactured in space. Likewise, the possibility of producing specialty glasses and products and advanced alloys is being considered. Overall cost-benefit assessments, however, are still rather controversial.

50. Space-processing also seems very promising for the production of pharmaceuticals such as erythropoietin to stimulate red cell production in fighting

kidney and blood diseases, anti-haemophilic factors to clot blood in haemophiliacs, urokinase to reduce clotting in stroke and phlebitis victims, and beta cells which might provide a single-injection cure for diabetes. Electrophoretic chambers for the experimental processing of such biological products will be flown aboard the Space Shuttle.

51. A number of materials science experiments will also be carried out by European countries and the United States, using the SPACELAB. Facilities for these include the special fluid physics module (FPM), developed in Italy, to be flown on the first SPACELAB mission, and a fluid experiment system (FES), under development in the United States, to be flown during future SPACELAB flights. The FPM will investigate fundamental fluid physics problems such as natural and enhanced column stability, convection, drop coalescence, liquid/vapour interfacial forces, etc. The FES allows fluid phenomena investigations using optical observation techniques. Its data capability includes holographic photographs and a flow visualization video system.

52. Much work remains to be done in material sciences to develop a better understanding of the various processes involved. In order that rapid progress be made in this field, it is essential that the results of experimentation continue to be widely disseminated and readily available to scientists all over the world. There is now an increasing probability of economically-viable production in space of new materials in the near future. It is desirable that the benefits of these developments be made available on reasonable terms to all nations and all mankind (see also chap. II, paras. 306 and 307).

53. Early experiments with animals in space were quickly followed by manned missions of gradually increasing duration. Man demonstrated his ability to function in space and was given increasingly complex tasks. In a number of cases astronauts and cosmonauts solved problems that would have crippled unmanned vehicles. There were, however, physiological effects of microgravity, both during and after spaceflight, that at first appeared to limit the effectiveness and the duration of manned missions. "Motion sickness" limited effectiveness in some cases but was found to disappear after a week or two. Loss of calcium from the bones, muscular atrophy and redistribution of body fluids caused problems, but these were eventually largely overcome by physiological adaptation, rigorous exercise and devices to simulate the effects of gravity. Cosmic radiation also poses a hazard, particularly in the radiation belts, but space vehicles can be shielded to the extent that long duration missions in low earth orbit and short missions through and outside the belts can be reasonably safe.

54. Manned space missions and general scientific interest stimulated work in the field of space biology and medicine. Neither the microgravity environment nor the complex spectrum of space radiation can be produced or effectively simulated in ground-based laboratories. Consequently, studies of the influence of these factors on living matter will only be possible to the extent that experimental facilities in space become available. Both factors have at least two characteristics of exceptional biological interest: they have not been encoun-

tered by living organisms throughout the entire history of their terrestrial existence and evolution, and living organisms display varying degrees of tolerance of each factor, permitting varied and systematic quantitative experiments to determine the nature and extent of their effects. For biology and medicine, the space environment therefore represents a new and powerful research tool: it makes possible experimental investigations into problem areas in which theory is in no position to make trustworthy predictions.

55. Our current state of knowledge in this field derives from experiments carried out in space over the last two decades, notably those conducted during recent years in the US SKYLAB and the USSR Cosmos Biosatellite and Salyut series. Of the problems that have so far aroused interest, and continue to do so, many involve fundamental issues in the biosciences. Cardinal questions concern the biological significance of earth's gravity. Gravity strongly affects the behaviour of the liquid and semi-solid phases which comprise living matter. It always existed as it does today, and the evolution of all organisms has therefore taken place under its constant and pervasive influence.

56. Important experimental facilities already exist or are being developed in the USSR, the United States and European countries for research in the following areas:

(a) Basic physiological phenomena with respect to the three main sensing systems (vestibular, somatosensory and visual) related to spatial orientation, control posture and locomotion;

(b) Cardiovascular phenomena and conditioning of the cardiovascular system during prolonged exposure to weightlessness;

(c) The possible effect of microgravity on cell proliferation kinetics;

(d) Cell and molecular biology.

It is desirable that opportunities to use these and other facilities continue to be made available to scientists of all countries - especially of those that do not now have the capability of setting up their own experimental facilities for such work - in a co-operative and co-ordinated manner. The results thus obtained would also be useful for clinical medicine and public health care.

57. The USSR has conducted a number of long-duration space flights, resulting in a great deal of important medical data. A major conclusion has been that there is no indication of the impossibility - or of hazard - to future extended manned space flights. This is especially important in view of the likely need for human intervention for fabrication or erection of large structures in space, for which concepts and designs already exist. A significant part of the scientific research programme of Soviet manned flights has been concerned with biological experiments. Fundamental vital activities - heredity, cell division, embryonic evolution processes, structure formation, etc. - were studied. Important data on gravitational biology, cytophysiology, comparative and evolutionary biology have been obtained.

58. While most biological experiments in space have focussed on the practical problems of manned space flight, some missions have studied the fundamental biological effects of microgravity. Effects of stimulated growth of micro-organism, muscular and skeletal abnormalities in rats and multidirectional growth in plants have been noted as preliminary observations. Data from planetary landing missions have been analysed with regard to the possibility of life. In the case of Mars, which seems least hostile to life as we know it, a number of experiments conducted by the US Viking spacecraft on the planet's surface were specifically designed to detect biological activity, and yielded generally inconclusive results. While there is yet no reason to believe that life should be unique to earth, there is as yet no convincing evidence of life elsewhere.

59. Experimental research in the microgravity environment is a rapidly growing space discipline which will lead to advanced scientific knowledge and new applications. The research will develop through utilization of existing and planned manned space systems. There is also a clear trend to utilize fully automated orbital platforms which will provide microgravity conditions, energy, power, control mechanisms, etc., and will guarantee the recovery of samples and test objects. Examples of fully automated systems are biosatellites of the COSMOS series, the proposed Space Shuttle long-duration experiment facility, the Soyuz-T-Progress, and the projected materials experiment carrier (National Aeronautics and Space Administration (NASA)) and MINOS (Centre national d'etudes spatiales (CNES)). In view of the long-term implications of this work and its interest to humanity as a whole, it is desirable that research in this field be supported and carried out in a co-operative and co-ordinated manner.

## C. Telecommunications and broadcasting

60. Telecommunications was one of the first applications of space tecnology and, beginning with the passive relay of voice and video by a satellite in 1960, it progressed very rapidly to operational international service in 1965, using active geostationary satellites and satellites in high elliptical orbits. Communication satellites have now become a routine and vital element of the international telecommunications network. They have also become an integral part of the domestic network in several countries. There are .... active communications satellites in geostationary orbit. Out of these, .... satellites are international satellites, .... satellites are operated by the developing countries and .... satellites are operated by the developed countries.

61. The rapid advances in this field have been made possible by the tremendous technological progress in related fields, especially micro-electronics (large and very large-scale integration), transmitters (travelling wave tubes and solid-state devices), antenna design, high-frequency techniques, communication techniques, micro-processors and the field of electronics in general. While these fields have contributed to space, there has been a corresponding positive feedback and space technology itself has accelerated - even caused - some of these developments.

62. These and other advances led to the development of large, high-power

spacecraft which could be kept relatively fixed on-station in the geostationary orbit, making possible a technology inversion by which the complexity was shifted from the ground to the spacecraft. Thus, one could - in effect - interchange the ground and spacecraft antenna: have the large antenna on the spacecraft and use a small antenna on the ground. Further progress in this direction, including the use of deployable antennas and solar arrays on spacecraft, led to the development of the direct-broadcast satellite. The first of these was the United States ATS-6, launched in 1974 and used extensively by the United States, India and other countries for experiments in direct broadcasting to augmented community television receivers. Similar experimental satellites have been developed by the USSR and Japan and jointly by Canada and the United States. The USSR, in fact, has had an operational satellite broadcasting service (EKRAN) since 1976, and Canada operates an experimental television broadcast service using its ANIK-B spacecraft. Much current activity in this field is directed towards the development of larger, more complex, more powerful and capable satellites.

63. The technology-inversion mentioned above inevitably results in significant cost increases for the satellite. While the economic attractiveness of this depends upon an overall system cost analysis of alternative configurations, complex and large satellites are often economical because of the substantial savings in ground segment that they make possible. Such satellites also help to reduce the pressure on the geostationary orbit (see chap. II. G). The use of such satellites - with the large investments involved - also implies a very extensive ground segment, so as to fully utilize them. In fact, in many such systems the ground segment (especially when maintenance and operation are taken into consideration) accounts for a large proportion of the total system cost. In such cases of obvious economic feasibility, there is, therefore, a great need for reductions in the cost of ground hardware, and all work aimed at doing this is worthy of encouragement and support by all countries and international organizations. This is also important in the case of international or regional systems, where the space segment may be rented or its cost shared between many countries, but the cost of each ground installation is borne fully by the country concerned. It can be expected that the technical development and the greater production due to higher demand will lead to a substantial reduction in cost for, inter alia, ground segment hardware.

64. [Most communication satellites are in the geostationary orbit. Since these satellites operate within limited designated frequency bands, and since they must be sufficiently separated to avoid interfering with each other's communications, there is a limit to the number of satellites that can operate in the geostationary orbit. Certain parts of the orbit for certain frequency bands are rapidly approaching saturation. This aspect is discussed in greater detail in chapter II G.]

[After second sentence, add: About .... geostationary satellites operating at the same frequency bands can be accomodated in GSO under current regulations governing radio interference.]

[Replace third sentence by: Certain parts of the orbit for certain frequency bands and specific coverage areas may be approaching congestion. Technological advances are underway, however, which will permit, among other changes, the closer spacing of satellites and their sharing on a non-interfering basis for various types of communication.]

[Replace full paragraph by: Most communication satellites are in the geostationary orbit. Since these satellites must be sufficiently separated to avoid possible collision and radio interference, and since they operate within limited designated frequency bands, the number of satellites that can operate in the geostationary orbit in accordance with the ITU regulations is limited. Certain parts of the orbit for certain frequency bands are rapidly approaching saturation. This aspect is discussed in greater detail in chap II G.]

65. Advancing technology and increasing traffic have led to decreasing cost per circuit for satellite communication (e.g., INTELSAT's satellite utilization charge per circuit has been reduced by a factor of six since 1965). The cost per circuit has decreased from U.S. $64,000 in 1965 to U.S. $9,360 in 1981. Traffic has also increased from 150 half circuits in 1965 to 50,244 half circuits in 1981. The share of the developing countries in this traffic was nil in 1965 and about 35 per cent in 1981. Another major factor in the decreasing cost of satellite circuits has been the increased lifetime of satellites. Reliability and quality assurance have helped do this and, at the same time, have spread the culture of reliability engineering and failure analysis to other sectors of industrial effort, with very beneficial results. Launch vehicles capable of carrying larger payloads have also contributed to the economics of satellite communication.

66. The possibility of launching, deploying or even fabricating large structures in space (see chap. II I) could lead to another revolution in space communication. Such structures could have large antennas and high power outputs making possible communication between extremely small terminals. The possibility of "repairing" satellites in orbit would also make possible the use of more sophisticated systems, thereby permitting simpler ground equipment for reception. Advanced concepts like on-board (spacecraft) switching and signal processing combined with new communication techniques (spacecraft switched TDMA, code-division multiple access, etc.) could even make possible pocket size, individual "earth stations". There are however constraints on the realization of small terminals in particular frequency bands due to the power flux density limitations necessitated by the fact that these bands are shared by ground and space services. Given the large investment in existing ground (conventional) systems and their importance, regulatory provisions have been specified by World Administrative Radio Conferences (WARC). In view of the immense possibilities opened up by advancing satellite communication technology, it is desirable that the ITU continue to study the optimum allocation of bands for various services and the criteria for sharing, with a view to adopting appropriate changes at future World Administrative Radio Conferences.

67. While greater radiated power from the satellite enables reception by simpler ground equipment, the use of smaller antennas on the ground requires wider spacing of satellites in the geostationary orbit in order to avoid interference. Thus, we have a paradox that is common to other sectors of activity also: the intensive application of an innovation often degrades some of its most desirable features. Careful studies of various trade-offs are therefore needed to arrive at an optimum solution.

68. However, partly because of the existing constraints, exciting new developments have been taking place in higher frequency bands. The 14/11 GHz band is already being used for operational purposes by INTELSAT and some countries have carried out experiments in the 20 and 30 GHz bands. Satellite television broadcast systems in the 12 GHz bands will soon be operational as well. Other techniques such as polarization diversity and spot beams may also help to reduce inter-satellite interference. Satellite-to-satellite links will avoid multiple hops and would increase the efficiency of global communication. All these developments may also contribute to a lessening of the pressure on the use of GSO in certain frequency bands and orbital arc-segments, mentioned earlier, and deserve active support.

69. Large "space telephone exchanges" have been proposed, which would be electronic exchanges in space, receiving, processing and transmitting signals to appropriate locations through large, narrow beam antennas. Such structures are now feasible and most of the technology for implementing such a system is already at hand, although its launch and assembly may at the moment be difficult and uneconomical. Nevertheless, it is possible that such a system may one day become economically attractive; in this case the development of a large communications platform could be undertaken to satisfy, in the most economical way, the needs that would appear at the international or regional level. The expected impact of such (and other) large platforms, on GSO must be thoroughly studied in order to avoid any unnecessary congestion in GSO, taking into account the equal rights of all countries to this particularly important international resource.

70. An alternative to such single large platforms, and one that may be immeditely feasible, is clusters of (electronically) interconnected satellites. Since these could basically serve the same purpose as single large platforms, and both will also be more efficient from a GSO-usage point of view, its develoment too should be encouraged. Unnecessary congestion in GSO should be avoided taking into consideration the equal rights of all countries to GSO, which is one of the most important international resources.

71. A recent development of great promise is the rapid progress in the field of fibre-optic technology. It seems likely that there may soon be a major shift of international and trans-oceanic traffic away from satellites to high-capacity fibre-optic systems. Such a development will lessen the pressure on the GSO and also on the frequency spectrum.

72. Satellite broadcasting is an increasingly important application of space technology. Direct satellite broadcasting of radio signals to portable and

automobile receivers is likely to be possible in the near future and the CCIR has only recently completed a study on this. The use of satellite broadcasting - especially for education - is discussed in greater detail in chapter II E.

73. The increasing power that enables satellites to broadcast directly to small home or community receivers and high gain receiving systems on satellites makes possible communication with small receivers and transmitters on ships, aircraft or ground vehicles. The system of INMARSAT for global maritime communications is now operational, and it is desirable that technologies and systems be developed that will enable smaller ships as well to use satellites for maritime communication (see also chap. II, para. 155). Currently, joint studies and developments have been undertaken by INMARSAT and the International Maritime Consultative Organization (IMCO) in close co-operation with the International Radio Consultative Committee (CCIR) of ITU aimed at the establishment of a future Global Maritime Distress and Safety System. In this new system Morse radiotelegraphy will be replaced by digital selective calling, radiotelephone and narrow band direct printing using terrestrial or satellite communication facilities. It is intended that distress alerting via satellite will primarily use small low-power distress transmitters that can be carried both on ship and survival craft or be fitted into floating buoys and be activated should a ship sink. The implementation of this future system is envisaged around 1990. This system together with the availability of low power distress transmitters could be of great value, especially for those developing countries that constitute archipelagos with extensive small ship traffic between their numerous islands or countries with considerable fleets of small coastal or fishing boats. Satellite systems for aeronautical and land-mobile communications are also likely to be developed in this decade. The International Conference on the establishment of an international maritime satellite system, 1975-1976, recommended the study of multipurpose satellites providing both a maritime mobile and an aeronautical mobile capacity. There may be economic advantages to be gained from multipurpose satellites serving both the maritime and aeronautical communities, although the operational and institutional consequences of such an arrangement need to be studied. In an attempt to encourage studies on purely technical aspects, the INMARSAT Council has indicated that the INMARSAT space segment could be used for test and demonstration purposes for a wide range of mobile satellite terminals. The International Civil Aviation Organization (ICAO in 1981 completed a comprehensive study which assesses on the basis of extensive computer simulation the potential and economic viability of an aeronautical satellite system as compared to existing and possible alternative aeronautical communication systems. The early implementation of a suitable system should be encouraged (see also chap. II, para. 157).

74. Lightweight transceivers which operate using appropriate satellite links are especially attractive for use in disaster relief operations and in the dissemination of warnings of impending disasters. Such a system, providing ready and reliable communication with disaster sites, could be defined through an analysis of detailed operational requirements and should be implemented operationally. International organizations which operate commercial components of such a system should make these components available at minimal or no cost

during disaster operations. An appropriate body of the United Nations system should be mandated to govern the over-all operations of the disaster operations communications system.

75. Satellite communication is being put to wider and newer uses. These include video conferencing and various types of interactive use, computer interconnection, data communication, electronic mail, etc. While these basically use the technology of "conventional" satellite communication, they depend on new interface equipment, special software and new communication techniques like packet switching in its various forms. Techniques such as spread spectrum, demand assignment, multiple access, digital speech interpolation, etc. have by themselves created major advances in the field of communication. Much of this depends upon very basic, fundamental work in such fields as communication theory. Similarly, the use of higher frequencies depends upon extensive scientific investigation of propagation phenomena. It is therefore necessary that all possible encouragement and assistance be provided - especially to developing countries - to undertake such basic science pursuits.

## D. Meteorology

76. Both meteorological as well as earth resources and environmental satellites use remote sensing techniques. They can be considered as complementary and partially overlapping subsystems of a global earth-observation system. This is the reason why certain "remote sensing" applications such as large-scale air and water pollution monitoring are also referred to in this section.

77. Despite the impressive developments in technology, man is yet dependent on the weather for a large proportion of his sustenance and wealth. In fact, a better understanding of the environment has further emphasized his dependence on weather and on the climate. All countries are - to a greater or lesser extent - affected by adverse weather phenomena and climate changes. Developing countries are particularly dependent upon the weather and its vagaries - not just for food, but also for agriculture-dependent industries (e.g., textiles), cash crops like coffee and tobacco, and also for hydroelectric power. Forecasts that are even slightly more accurate or can be made a little more in advance would mean a great deal, both economically and in terms of advance action to prevent human misery caused by storms, floods, and droughts.

78. In the few years since the transmission of the first visible cloud images from space in 1959, much progress has been made through space meteorology in trying to tackle some of these problems. Rapid technological progress has permitted the extension of observations from the visible to the infra-red, ultraviolet and microwave regions of the electromagnetic spectrum and the development of a global system making complementary use of polar orbiting and geostationary satellites. The first satellites used television cameras to provide pictures of cloud patterns. The introduction of thermal infra-red scanning systems made possible the measurement of cloud data that could be used in the computer models of the atmosphere that are the basis of weather forecasting. The first operational system, based on these techniques, included the automatic picture transmission (APT) system which made satellite imagery freely available

in real-time anywhere in the world to anyone who could build or buy a simple low-cost ground receiving system.

79. As higher resolution sensors were developed, it became possible to make meteorological observations from geostationary orbit, where the constant field of view permitted frequent observations and also enabled satellites to relay ground measurements and processed satellite data between ground stations. In particular, the raw digital image data are received by primary receiving and processing facilities which retransmit corrected and processed data in simpler formats to less expensive secondary user stations. Sequential images from geostationery satellites, acquired at intervals of typically 30 minutes, can be compared to determine wind speeds at cloud level. During the First Global Atmospheric Research Programme (GARP) Global Experiment (FGGE, 1978-79), five geostationary meteorological satellites were in orbit to provide continuous coverage around the world. The Global Observing system within the World Weather Watch (WWW) of the World Meteorological Organization (WMO) now includes geostationary meteorological satellites launched by the United States, (GOES)(3); Japan, GMS (2); the European Space Agency (ESA) METEOSAT (2); and a system of polar-orbiting meteorological satellites operated by the USSR (the METEOR series) and the United States (the NIMBUS and TIROS-N series). These polar-orbiting satellites operate in the sun-synchronous orbits at altitudes of 800 to 1,500 kilometres. India and the USSR will also soon have geostationary satellites for meteorological purposes and these will provide coverage of the Indian Ocean area.

80. The use of high resolution Fourier spectrometers and multifrequency radiometers for atmospheric and mesospheric sounding in absorption bands in the infra-red and microwave regions has introduced the third dimension into satellite observations previously limited to cloud levels. These profiling sensors provide measurements of air temperature and humidity as a function of altitude, for use in computer models of the atmosphere or weather forecasting.

81. Air and water pollution monitoring is another activity made possible by new sensors. Radiometric and spectrometric measurements with better spatial resolution or through point sounding may be able to identify specific pollutants, their concentration, drift and dispersion. Source location will be improved by high resolution remote sensing satellites. There are plans to use laser radar (Lidar) systems aboard the SPACELAB for atmospheric studies. Development of technologies and techniques of pollution monitoring should be encouraged.

82. An important direction of experimental and future operational meteorology will be the monitoring of slowly changing atmospheric variables and the implications of these changes for long-term weather patterns. Satellite sensors are being developed to measure global albedo and the amount and distribution of carbon dioxide, chlorofluorocarbons, ozone and dust. These factors are affected by man's activities and long-term changes may give rise to changes in weather patterns with harmful environmental and economic effects. Satellite sensors provide the best means for accurately monitoring such global phenomena, and the further development of such sensors should be continued.

83. Observations over the oceans, particularly of such parameters as sea-state, sea-surface temperature and precipitation, are important for meteorologists. While data collection platforms (DCPs) (see para. 85 below) can collect such data *in situ*, microwave radiometers, microwave scatterometers and radar altimeters on-board satellites can provide this data over large contiguous areas or long profiles. Since these techniques are yet at an experimental stage, their further development must be encouraged and scientific studies in these fields need to be intensified.

84. Many problems of environmental monitoring can only be solved by combining high temporal resolution with (selectively) high spatial resolution. To cope with these requirements within reasonable data rates, future satellite systems will emphasize flexibility of sensor parameters. Long and variable focal length optics may be used in order to get, by ground command, either "wide angle" or "high resolution" imagery; a selection of filters and sensors may provide optimum spectrometric sensitivity for different tasks. The geostationary orbit will provide a synoptic view and the possibility of frequent observations. Development of such systems that provide frequent observations and transmit the data at low bit rates should be encouraged.

85. Data from meteorological satellite sensors need to be combined with ground, air and sea-based *in situ* measurements if their potential for improving weather forecasts and monitoring environmental parameters is to be fully exploited. Therefore, both geostationary and polar-orbiting meteorological satellites are increasingly being used for relaying data from manned or unmanned DCPs to central ground receiving stations which automatically decode, process and retransmit the data to specific users. DCPs consist of small automatic collectors and transmitters of data that can work without maintenance for long periods of time. They are normally installed in remote inaccessible land areas, attached to moored or drifting buoys or ships for monitoring sea conditions and currents, or flown on balloons to measure air movements and other parameters. Geostationary GOES satellites can relay the data of up to 10,000 DCPs every 6 hours. Polar-orbiting satellites can additionally be used for determining the position of drifting buoys by means of Doppler measurements. The use of DCPs with satellite relay is restricted to low-data rate transmissions (typically 100 bits per second). Therefore, DCPs are normally used in connexion with sensors for the measurement of slowly changing parameters such as temperature, humidity, atmospheric pressure, wind speed and direction, sea state, rainfall, snow height, etc.

86. Before the advent of satellites, balloons were used for gathering meteorological data from the upper atmosphere. Today, balloons and sounding rockets continue to play an important role in collecting meteorological data. Rockets are also used for dissipation of hailstorms that could otherwise cause damage to crops. Systems for such hailstorm control are operational in some countries, including the USSR and China. The use of such systems for other countries should be studied.

87. As data becomes available from more sophisticated meteorological satellites and as the science of meteorology advances, more accurate and longer

range forecasts will be possible, although the original goal of GARP to extend the reliability of weather forecasts to two weeks seems difficult. However, the full potential of current and future meteorological satellites beyond the stage of APT and weather facsimile (WEFAX) data reception can only be exploited by means of more sophisticated (S-band) direct receiving stations and the use of large, expensive computers for data pre-processing, analysis and modelling. Few developing countries are likely to be able to afford such investments on their own. Close regional co-operation or the establishment of regional or international centres is an attractive way for developing countries to derive the benefits of these technological advances without exorbitant investments or duplication of national efforts. The feasibility of setting up such regional or international centres for meteorlogical data reception and analysis is being examined by WMO, and should be encouraged. On the other hand, the centralization of such facilities is a viable solution only if there exists a well developed regional communications infrastructure which allows the minimization of the data turn-around time. Otherwise the near real-time availability of this data - an indispensible precondition for its usefulness - is lost. Before embarking on the establishment of such regional centres, it should therefore be examined whether already existing telecommunication links are sufficient to transmit the analyzed data to national centres or could be expanded at reasonable cost. Otherwise the local establishment of smaller and simpler, cost-effective data reception and processing stations might be the only viable solution. Another important precondition for the successful long-term use of meteorological satellites for operational weather forescast and monitoring of climate changes is that data are acquired over extended periods of time with at least part of the basic and well proven sensor and orbit parameters fixed in order to allow statistically valid evaluations. Best efforts must be made to ensure, to the extent possible, such "continuity" in all future technical developments of operational meteorological satellites.

88. Since forecasting or understanding of local weather requires integration of relevant data collected in many countries and over large regions, progress in this field is possible only through close co-operation between nations. The whole field of meteorology has a history of such co-operation and space meteorology has continued this tradition. The world-wide free availability of data from meteorological satellites through decentralized direct reception, and rapid world-wide data exchange is crucial for the effective use and rapid integration of satellite data with data from ground-based networks. It is desirable that such co-operation - exemplified by co-ordination of efforts and exchange of data - be not only continued, but further intensified.

## E. Remote sensing

89. Remote sensing technology with its various components can be considered as a technical imitation, modification and extension of the natural eye-brain system. Using remote sensing techniques from a high vantage point, man can extensively and systematically derive environmental information over a wider range of the electro-magnetic spectrum and with a higher, quantifiable and thus objectively reproducible, spectral and radiometric resolution.

90. Though satellite remote sensing systems are - in the formal sense - still at the experimental or pre-operational stage, many countries have made considerable investments in ground stations, processing and analysis facilities and the data is being used on a near-operational basis. This indicates a clear recognition of the importance of satellite remote sensing and its potential contribution to economic development; it also implies an understanding or hope that data will continue to be available. Definite indications in this regard from satellite operators are important, so that countries can continue to invest in ground equipment or devise alternative means of obtaining the data.

91. With respect to sensors used, a principal distinction has to be made between passive and active remote sensing systems. The first requires a natural supply of reflected (solar) or emitted (earth) radiation, while the latter provides the initial signal itself and records the object's response (reflection, scattering, fluorescence emission, etc.). Remote sensors can be mounted on a large variety of air or space-based platforms operating at different altitudes and for different periods of time. Consequently, satellite remote sensing should be recognized as being just one component in a complex multistage integrated systems approach, which also includes extensive sampling of ground information. The technology as well as the methodology developed for satellite remote sensing has therefore a significant bearing also on the efficiency of a purely aircraft-supported remote sensing system and vice versa.

92. From the early manned satellites with short duration missions, astronauts and cosmonauts used conventional hand-held photographic cameras to take pictures of the earth from various altitudes and at various angles. While these pictures had very limited applications, they were dramatic and showed some unexpected features, exciting speculation as to what might be done. As satellites became larger and missions longer, systematic surveys could be undertaken and special camera systems were designed for remote sensing from space. Multispectral cameras were designed to use a variety of films and filters, allowing more flexibility in image processing for different applications.

93. A major advance was the development of automated satellites for weather and earth observations using multiband electronic sensors and real-time data transmission to the ground. These satellites made possible regular, repetitive surveys of the earth's environment and resources on a global scale. Within a few years, cheaper and more reliable linear arrays of electronically scanned detectors (charge coupled devices) are likely to replace the currently dominant electromechanical scanners. While electronic sensors tend to have poorer resolution than photographic systems and are thus less suitable for large-scale mapping, the advantage of regular coverage over many years offsets the resolution disadvantage in the case of monitoring changing phenomena. Furthermore, electronic sensors can make observations at infra-red and microwave wavelengths, beyond the sensitivity of photographic film.

94. The advantage of real-time data transmission can only fully be exploited by users if decentralized direct data reception and rapid, efficient data dissemination is guaranteed. Therefore, a growing number of countries are establishing remote sensing ground stations which generally provide data to all

countries within the zone of coverage. In order to take full advantage of the real-time data transmission and to manage the vast amount of data that will inevitably flow from future remote sensing satellites, further decentralization of ground data reception and processing facilities down to national and provincial scale may be desirable. The availability of cheap and versatile technology for the ground segment as well as the ability of user countries to develop an indigenous capability for designing, establishing, maintaining, running and adapting the components of the ground segment to advances in sensor technology are important pre-conditions in this respect. At present the scarcity of foreign exchange, as well as difficulties and delays in procuring spare parts or getting maintenance services not only hamper indigenous developments but also occasionally render existing facilities inoperative for long periods. Additionally, a number of users particularly feel the need for assurances from countries operating remote sensing space segments of continuing services with direct and unrestricted access to data of their territories at reasonable prices before embarking on extensive investments in ground facilities (see also chap. II, paras. 202 and 225). A number of operators of space segments feel, however, that, if continuity is to be assured, the prices that users pay will reflect a sharing of the cost of these expensive systems.95.In the last two decades, over 30 earth observation satellites have been launched, mostly from the United States and the USSR. Since 1972, remote sen- sing has become increasingly "quasi-operational" through the LANDSAT satellites of the United States. Three have been launched and LANDSAT-D is scheduled to be launched in 1982. The Soyuz, Salyut, Meteor and Meteor-Priroda spacecraft of the USSR have also collected extensive remote sensing data.

96. By the end of the decade there are likely to be six or more remote sensing satellite systems operated by national or regional agencies. Apart from the United States and the USSR, remote sensing systems are likely to be set up by Canada, China, ESA, France, Japan, India, and possibly other countries. While discussions are under way to make some of these systems compatible with existing ground stations and complementary to each other, the design of each sytem will correspond primarily to the requirements and capabilities of the agency concerned. The sensors on these satellites will operate at visible, infra-red and microwave wavelengths with a variety of resolutions and fields of view, thereby allowing the user to select the system or combination of systems that best meets his needs. By the end of the decade a number of satellite systems will be operational and prices for data are likely to rise to cover the costs of developing and operating the systems. A number of users have expressed the need to institute arrangements to enable them to have continued access to data at reasonable costs (see chap. II, para. 208).

97. Future satellites with data direct transmission will have higher spatial resolution and some will have pointable sensors and stereo-viewing capabilities (e.g., the SPOT system of France). Other new satellite sensors such as the thematic mapper of LANDSAT-D (United States) or the Soviet Union's FRAGMENT-2 have significantly improved spectral capabilities. All weather active sensors have already been flown - e.g., the microwave radar on SEASAT of the United States - and some future systems also include similar sensors (the United

States Space Shuttle flew an imaging radar and both ESA and Canada are considering synthetic aperture radar satellites).

98. The currently dominating trend in the development of electronic satellite remote sensing systems is towards multipurpose and multichannel (up to eight) high-resolution sensor packages, sometimes including an all-weather capability (radiometer, scatterometer, altimeter and imaging radar). This results in extremely high data rates (up to about 200 megabits per second) and the use of very high frequency (around 8 GHz) technology for data transmission andreception. The latter requires costly augmentation of existing (2 GHz band) data reception facilities and poses significant problems with respect to data pre-processing and handling.

99. This tendency has spurred studies into possibilities of on-board data processing aimed at data compression and reduction of redundant information. However, at present no tecnologically viable and generally accepted solution is in sight. The optimal data compression algorithms would change from scene to scene and would depend upon the specific application area, thus reducing the usefulnes (or even being detrimental) for other applications. A retransformation of compressed data into its original form would be very expensive and would entail some loss of information. Nevertheless, further research in this field is desirable.

100. On the other hand, various studies of current as well as potential applications of earth observations from space seem to indicate that satellite systems based on a total systems concept incorporating both space and ground segment and taking into account special needs and conditions of major application areas and user communities could be a viable alternative or at least a cost-effective complement to highly sophisticated, multi-purpose remote sensing satellites with their immensely high data streams. Data rates between 5 and 15Mbit have been proposed for such dedicated remote sensing satellites. One such concept for an agricultural application would allow for flexible selection of both spatial and radiometric spectral sensor parameters depending on actual user requirements. Other application areas for dedicated remote sensing satellites are geological surveys, mapping or remote sensing in tropical areas. The latter could be achieved by, for example, launching the satellite into a high or near-equatorial orbit providing high temporal resolution in order to cope with prevailing cloud cover.

101. Besides these developments in the field of electronic sensors, high resolution panchromatic and multispectral photographic sensors with high geometric fidelity will continue to be flown on automatic as well as manned space missions. Their use will not require sophisticated technology or the establishment of costly ground segments. It will probably remain superior for large-scale mapping (down to 1:50,000 as demonstrated by the USSR Soyuz-22) of quasi-stationary or slowly changing phenomena observable in the visible and near infrared part of the spectrum. Space photography, therefore, constitutes a valuable complement to the frequent direct reception at low data-rates of medium resolution remote sensing imagery. It is a low-cost approach with respect to data

analysis and therefore is particularly attractive for developing countries which cannot afford large investments in ground hardware.

102. While this section has dealt primarily with the satellite component of a remote sensing system, it is clear that other element on earth are equally - or even more - important. These include not only the data reception facilities, but also the data processing and analysis hardware, the computer software, equipment and techniques for "ground-truth" collection and, of course, the organizational and utilization aspects. Data processing and analysis facilities may range from large, sophisticated and expensive computers to simple, inexpensive photo-processing and visual interpretation equipment. The choice of technology and equipment depends upon a country's needs and resources. However, it needs to be emphasized that a great deal can be done through simple, inexpensive equipment and appropriate techniques (e.g., colour composites, diazo prints and even simple overlay and projection equipment).

103. The systematic collection of ground truth is indispensable for the proper interpretation of remote sensing data. The creation of a data bank of representative examples of radiometric-spectral and/or structural-textural appearance of typical ground objects and feature associations in the respective types of remote sensing data ("signature bank") would be a desirable activity requiring comparatively little investment. Of course, even here there is a wide range of possibilities and costs - from ground truth radiometers to more expensive mobile platforms (e.g., "cherry pickers") that carry a wide array of equipment like spectrophotometers, scatterometers, etc. It is important to note that signatures and ground truth are area-specific and therefore countries involved in remote sensing have to carry out this work for themselves. The aspects of ground truth, data processing and analysis need greater emphasis and it is desirable that countries devote special effort to work in these fields.

104. With the advent of operational remote sensing satellite systems and with more and more countries already establishing ground segments for data direct reception and/or data processing and analysis, great attention has to be paid by countries developing and operating space segments as to the complementarity and compatibility of their data systems with those of other satellite sytems. This will help to avoid redundant experiments, to minimize costly changes of existing ground equipment, to guarantee a long-term availability of satellite data and to enable their broadest possible use with existing facilities (see also chap. II F). In this connexion, the importance of a complementary future use of the geostationary orbit for environmental remote sensing using satellites with selectively adaptable sensor parameters becomes obvious, particlarly for tackling problems of monitoring and mitigating disasters.

105. Likely future developments include the continuing use, with great benefit, of photo-interpretation techniques by a large number of users, particularly in developing countries. At the same time the use of computer processing, interactive and automatic analysis and integration of interpreted information into computer data banks is likely to grow very rapidly. Data from a variety of remote sensing systems, along with meteorological, climatological and hydrological data and economic, social and demographic statistics, may be formatted

to a common geographic framework. A network of terminals could allow users to obtain specialized maps compiled from these data bases according to any combination of parameters specified by the user. In general, systems are likely to become more user-oriented.

### F. Navigation and geodesy

106. Position determination - in real time for navigation and with an acceptable delay for geodetic purposes - is an increasingly important requirement in a wide range of modern human activity. It has become essential in civil engineering, environmental planning, resources exploration and management, transportation and traffic control, search and rescue operations, etc. It is also a vital tool for a deeper understanding of the internal structure and dynamics of our planet and for studying crustal motions in connexion with earthquakes. These activities require accurate position determination and monitoring of position changes in space and time.

107. Before the advent of satellite technology, the classical task of geodesy, i.e., the determination of the figure and size of the earth and of the geometry of its surface, had to be solved by precise determination of the geometric connexions between single points at the earth surface as well as of the parameters of the terrestrial gravity field and by finding a suitable mathematical model which fitted these measurements best. Position measurements by means of satellites provide instead geocentric co-ordinates of surface points and thus data on the physical earth's surface without assumptions and hypotheses on the figure and the internal structure of the earth. Besides this, satellite technology has demonstrated its unique capability for high-precision geodetic measurements and navigation on a world-wide scale, covering also with the same accuracy the vast ocean areas. The synoptic view and frequent repetitive coverage of the earth surface are major advantages offered by satellites. Particularly in the case of frequently-repeated precise vertical position measurements along long traverses, the costs are considerably less than those incurred using conventional methods. This, and the fact that many developing countries are not well mapped, makes geodesy an especially relevant and important application for developing countries. The low investment on ground equipment and the high pay-offs in terms of new information would be attractive and suitable for most countries.

108. Other important tasks of geodynamics, including earthquake prediction studies, monitoring variations of polar motion, measuring tectonic plate movements over large distances with an accuracy in the decimetre - and centimetre - range and monitoring the earth rotational period with an accuracy down to 100 micro-seconds, can only be solved by means of modern satellite and space technology.

109. Principally, observations of an orbiting satellite can be used to determine the relative positions of the observer and the satellite. If the position of the observer is known, the position of the satellite can be calculated and vice versa. Once the satellite orbit is accurately determined, an observer anywhere in the world can determine his position. For navigation, the observer

wants to use simple equipment to make a quick determination of his position which may be changing quite rapidly, while for geodesy precise position determination - with fewer restrictions as to time and complexity of equipment - is required. The technologies of satellite tracking, navigation and geodesy are therefore very closely related and have developed in parallel.

110. Early satellite tracking was based on radio interferometry using radio beacons on the satellites. More accurate observations for checking the radio determinations and for correlating ground geodetic networks were obtained by photographing simultaneously the satellite track against the star background from several ground stations. Already these early tracking data showed that the figure of the earth is pear-shaped, departing from the theoretical assumption of a rotation ellipsoide by up to 10 or 20 metres. But these methods were not yet sufficiently accurate for geodynamic applications. To meet these precision requirements, new space geodetic techniques such as laser ranging to and from satellites, microwave interferometry using distant extraterrestrial radio sources (e.g., quasars) and satellite radar altimetry have been developed.

111. Laser ranging to satellites was originally developed to improve the precision of satellite orbit determination. Now it has become also an invaluable geodetic tool to determine station positions with an accuracy ranging from several decimetres down to 1 to 2 centimetres. The latter is currently achieved only by a few fixed stations but design goals for mobile laser stations under development are also aiming at this precision, which is required for regional crustal deformation studies and actual measuring of tectonic plate motions. In order to achieve this high precision, special geodetic satellites have to be compact, heavy and placed in high altitude orbits in order to minimize the effects of air-drag and of gravity anomalies. Also, a very high level of technical sophistication in hardware is required which includes accurate time and frequency standards, high-power short-pulse duration lasers and wide-band recording systems. The hardware required to achieve 1 to 2 centimetres positioning accuracy over distances of hundreds and thousands of kilometres is as yet available in only a few countries and the world-wide distribution of fixed laser ranging stations is rather uneven. It is therefore desirable that wider deployment of both fixed and mobile high-performance stations take place, so that internationally co-ordinated measuring campaigns can help develop a better scientific understanding of the earth and its dynamic features.

112. Studies have shown that space-based laser ranging equipment with the passive retroflectors attached to the ground targets might be a useful and cost-effective alternative system for rapidly surveying the relative positions of sites with a few tens of kilometres' spacing but spread over fairly large areas such as tectonically active regions. The development of such equipment therefore deserves to be encouraged.

113. Highly advanced computer modelling is needed in order to interpret the results of high precision laser measurements in the centimetre range taking into account the earth's gravity field, earth tides, ocean loading and the effects of earth's precession, nutation, diurnal rotation and relativistic

effects. International co-operation in this, through a pooling of data and knowledge, could greatly accelerate progress in this field.

114. Satellite laser ranging and radar altimetry have also greatly contributed to a much more detailed presentation of the earth's gravity potential up to harmonic order 36. Recently launched dedicated gravity field mapping satellites will soon allow determination of the gravity field with an accuracy of several milligals and with a spatial resolution of about 100 kilometres. This is roughly equivalent to obtaining the geoid at this resolution to an accuracy of a few decimetres. These missions have recently been supplemented by detailed mapping of the earth's magnetic field from satellite to an accuracy of a few nT. Besides geodetic satellites, laser ranging of the moon has also been used for studying terrestrial geodynamics, providing information on long-term changes in polar motion and the earth's rotation rate.

115. The second basic method of space geodynamics involves radio interferometry by simultaneously receiving and later cross-correlating the radio noise from distant radio sources at widely spaced antennas. Accuracies of about 4 centimetres have recently been reached over distances of several thousand kilometres. The results are obtained in an inertial reference frame. Systems planned to be operational in the next few years will provide daily estimates of polar motion and earth rotation with expected errors of about 5 to 10 centimetres in pole position and only 100 micro-seconds in time. These stations will also serve as base stations for crustal deformation measurements and plate motion studies by means of mobile very long baseline interferometry (VLBI) stations.

116. Accurate VLBI measurements require extremely precise timing. Hydrogen maser clocks have been used as the frequency standard in the most successful VLBI programmes. These clocks are expensive and not yet commercially available. Also the tape recorder requirements are very stringent. Data rates in excess of 100 megabits per second have to be recorded, which is equivalent to recording 20 television channels simultaneously. These technological difficulties in VLBI are offset by the advantage that VLBI stations can be made small and highly mobile. In order to check the validity of high precision laser ranging and VLBI measurements, both systems should be used in parallel with considerable overlap of the network of observation sites of the two types.

117. The use of satellites for navigation began early in the space age with the use of Doppler analysis of signals received from continuously radiating space-based radio beacons of high frequency stability which also regularly broadcast the satellites's orbital data. The equipment and the calculation techniques have been refined since, but the basic system is still current today. If a large number of measurements are taken over an extended period of time using more complex data processing, the results can even be sufficiently accurate for use in geodesy and geodynamics. It is therefore desirable that the computation techniques, equipment and necessary information be widely disseminated.

118. The same method - of measuring the Doppler shift - is also used for

localizing the position of fixed as well as mobile platforms on land and in the sea or air. These could be data collection platforms or equipment on board ships, aircraft, etc. Based on this, search and rescue systems have been devised for locating ships, aircraft or land vehicles in distress. Demonstrations of such search and rescue systems are being planned by the USSR and co-operatively by Canada, France and the United States.

119. Both the United States and the USSR have satellite navigation systems in operation. The Tsikada low-altitude satellites of the USSR serve several hundred ships, off-shore drilling rigs and floating bases. The United States Navy Navigation Satellite System (NNSS) has satellites in 1,000-kilometre circular polar orbits and serves a wide variety of users from many countries. Improvements in computational techniques have reduced the position-fixing error to less than 1 metre.

120. A proposed advanced navigation satellite system, being set up by the United States and called the Global Positioning System (GPS or NAVSTAR), is scheduled to be fully operational by 1986. It will comprise 18 satellites in circular 20,000-kilometre orbits, six each in three equally spaced orbital planes. This would ensure that a minimum of four satellites would always be in view of any given station, thus allowing immediate and extremely accurate three-dimensional position fixes by means of independent range and Doppler calculations. Ground receivers can be made very small and easily portable because of high signal strength.

121. Further processing of the data is expected to provide absolute positions in the 1 metre accuracy range, and considerable advances have been made towards the adopted goal of positioning by Doppler satellite to an accuracy of 10 centimetres or better.

122. Using VLBI techniques and GPS, a number of groups have demonstrated subdecimetre three-dimensional accuracy on baselines of several hundred kilometres. These results have encouraged the development of transportable VLBI stations for possible monitoring of the small (1 to 10 cm per year) movement of crustal plates for earthquake studies.

123. In view of the considerable scientific and practical utility for both rapid and high accuracy position location, it is desirable that world-wide access be provided to such systems.

124. Apart from navigation, space techniques provide an efficient way to improve the precision of geodetic measurements for position determination. The practical value of the extraordinary technological progress may not be immediately obvious, but what may be of interest today to geodesists alone may well, tomorrow, end up serving the needs of other disciplines, in particular those that are concerned with the management of the planet's resources and its environment.

## G. Space transportation and space platform technologies

125. It was the first launching of an artificial satellite into earth orbit by the USSR in 1957 that marked the beginning of the space age, and even today the criterion that defines a "space power" is the capability of carrying out a complete space mission, including the launch into orbit. At the same time, with the increasing importance and utility of space-based platforms, technologies related to space structures have also assumed significance.

126. As we progress to larger and larger systems in space, the demand for economy becomes paramount. If space systems using large space structures are to be economically competitive with terrestrial systems, their costs and the costs of transporting them to low earth or geosynchronous orbits must be minimized. Specified performance at minimum cost will dictate the way in which large space systems are designed and made.

127. With respect to space transportation systems, there has been a continual increase in payload capability, improvements in the precision of propulsion and orbit control systems and an increase in the reliability of systems. The efforts to improve the performance of space vehicles have been accompanied by persistent efforts to reduce the costs of launching. The large number of missions, and the growing proportion of these missions with a more or less "commercial" character, have made economic factors increasingly important. The future development of space transportation systems will depend largely on cost considerations. These considerations do not, however, imply a standardization of space transport technology. They have, rather, produced two fundamentally different options.

128. One technology is that of reusable vehicles. The costs of such partially reusable vehicles can be spread over a large number of missions. The increased complexity, and therefore cost, of making these systems wholly or largely reusable will be offset if they can be used a sufficient number of times. The other option is expendable vehicles whose cost can be reduced through the production of a relatively large number of vehicles. It is likely that these two options will remain in competition for some time, and perhaps indefinitely, since the wide range of requirements for space missions may best be satisfied by different transportation systems.

129. Cost reduction is also sought to be achieved by the simultaneous launching by one rocket of more than one satellite. China, ESA, the USSR and the United States have demonstrated the capacity of their launch vehicles to make such multiple launches. For the launch of geostationary satellites, the geographical location of the launch pad is also an economic consideration: payload capacities are significantly greater for a launch from near the equator than for one from a high latitude.

130. The technical resources for designing, building and operating the rocket-related technologies exist in a number of countries. With the systems that are now in use, those that are about to become operational and those that

are under development, users are assured of having a variety of systems available to meet their needs. This variety is important since it will contribute to unrestricted availability of space transportation services and will keep prices within a reasonable range. It also helps the user to optimize his satellite without being constrained to a single set of size, weight and launch environment limits.

131. The primary future demands will be to reduce specific transportation cost. This reduction of specific transportation cost will be achieved either through vehicle reusability, a technique which will certainly be further developed in the future, or by means of multiple launches carried out with expendable vehicles.

132. The United States Space Shuttle is the first of the reusable vehicles. Its launch mass is 2,000 tons and the payload it can carry to low earth orbit (LEO) about 30 tons. It is partially reusable: the winged "orbiter" vehicle is expected to be flown into orbit and back to earth more than 100 times, while the large propellant tank is expended each time. The solid-propellant boosters are recovered and are proposed to be reused for ten or more flights. The reduction in launch cost is expected to be substantial. The vehicle return capability has also another important advantage: expensive payloads which are compatible with the space shuttle, such as the Space Telescope, can be returned from space back to earth, refurbished, re-equipped and launched again, thereby offering considerable potential cost savings.

133. New and ambitious space projects - made possible by advancing technology and decreased launch costs - may require very frequent launches. As applications of space technology become operational and more widespread, there is also need to provide on an assured basis, launch facilities to all countries for peaceful applications or research. It is therefore desirable that:

(a) Launching services should be provided through bilateral or multilateral arrangements, on equitable terms, to all countries wishing to use them for peaceful purposes;

(b) Development of more economical space transportation systems should be encouraged in every possible way;

(c) The long-term consequences of the increasing number of launchings should be studied; if there are harmful consequences, corrective measures should be taken.

The increased frequency of launchings might also require a certain degree of co-ordination to avoid interference between launching operations at different sites. Consideration might also have to be given in the future to regulations to minimize the environmental effects of exhaust gases or of the re-entry of burned-out lower stages. (See also chap. II H and I.)

134. While launch costs per kilogram of payload have been decreasing, future fully reusable large launch vehicles are likely to allow further reductions. These vehicles with 100 ton payload capability are technically feasible with

present technology, but require a large development investment. Systems reliability and the consequent vehicle complexity require considerations of simple vehicles with fewer stages, which also reduce operational costs. Hence single-stage-to-orbit vehicles (SSTO) have gained increased interest in recent years. Thus, future launch vehicles are likely to be distinctly different from the multistage expendable launchers which are widely used today.

135. Orbit-to-orbit or orbital transfer vehicles are of particular importance for satellites or stations to be set up in geostationary orbits. In the past, transfers from low earth to geostationary orbit have been carried out by using liquid and solid fuel rockets. While cryogenics (liquid hydrogen and liquid oxygen) would allow an increase in capabilities, other propulsion systems are also being investigated. These include high-energy, storable propellants, solar-electric, and nuclear-electric propulsion. Each has specific advantages, and the choice must depend on the particular needs.

136. With advances in space technology, it has become possible to launch large spacecraft into orbit; simultaneously, new applications have been suggested which require even larger space structures. Space operations centres, space satellite power systems, manufacturing in space: these and other concepts have arisen from the rapid development of space technology. This includes improvement in systems for tracking, telemetry and command, increasing automation, a more precise understanding of the dynamics of structures in space, increasing efficiency and power in electrical generation systems as well as remarkable developments in the reliability of electronic and mechanical systems. These advances have been made possible by the technical advances in other fields, particularly in micro-processors. It is equally true, however, that the development of space technology has contributed to the development of these other fields through an extremely productive process of cross-fertilization. This implies that, if it is essential for a country wishing to make even a modest contribution to the development of a space system to have a minimum of industrial infrastructure, this same infrastructure will benefit from new capabilities and spin-offs resulting from participation in the space system.

137. The technical resources for designing and building space research and applications systems are developing in an even larger range of countries than is the case with space transportation systems, and this trend should be encouraged. In this field as well, economic factors are becoming more and more important. A reduction in the cost of space operations will require a reduction in the price of space systems through the development of more highly organized space industries. Economies can also be achieved by increasing the operational lifetime of space systems, thereby effectively spreading the cost over a longer period. Extended lifetimes will also serve the valuable purpose of helping to ensure continuity of operational service.

138. For large space platforms, structural aspects assume great importance - in terms of weight, size and ease of fabrication. Deployable structures have already been used for various space applications - especially for solar panels and antennas. Erectable structures permit high packaging density and are mass-limited rather than volume-limited at launch. However, erectable struc-

tures are likely to require human intervention through extra-vehicular activity in space. Automated assembly is also being studied, though, and may become possible in the future. Structures fabricated and assembled in orbit seem to hold the greatest promise for achieving low-cost structures for large systems. The development of automatic beam builder machines - capable of building structures as large as 1 kilometre or greater - for use in space is currrently under way in the United States.

139. Materials for space structures are of obvious importance in terms of optimizing performance at a given cost. The basic requirements are high stiffness, low density, long life and low thermal distortion. While considerable experience exists in the use of aluminium and aluminium alloys for aerospace purposes, it does not satisfy all the requirements. Titanium, steel, magnesium, beryllium and graphite/resin composites are alternatives being considered at present.

140. Large space systems would inevitably require considerable amounts of power. The present technology of solar-cell arrays is rapidly advancing through the use of low-density honeycomb cores and low-mass face sheets that provide greater power per square metre with lower mass. Future developments may include the use of gallium-arsenide or gallium-aluminium-arsenide materials with efficiencies above 20 per cent and multiband cells (which use a larger fraction of the solar spectrum) with efficiencies around 30 per cent. High performance batteries (possibly using nickel-hydrogen) long-life fuel cells, radio-isotope generators and nuclear reactors for high power are in various stages of consideration, design and development.

141. As mentioned earlier, some possible future space systems which will require large-scale operations in space, such as assembly of large multimission space platforms, or operation of permanent space stations, will demand new analyses of the appropriate role for man in space operations. It will probably not be possible to give a definitive or universal answer to the question of whether it will be more desirable, efficient and economical to give an important role to manned operations in space, to completely automate these activities, or to utilize some optimum combination of manned and automated sub-systems.

142. The realization of programmes of great magnitude will also require renewed consideration of wide participation by the international community in these activities. The enormous complexity, size and cost of these activities must not retard the progress that has been made - even if it is still modest - in disseminating space technology to a greater number of countries. Studies should therefore be made of the implications for international co-operation of these new concepts of large-scale space systems.

# II. APPLICATIONS OF SPACE SCIENCE AND TECHNOLOGY

## A. Current and potential applications of space technology

143. As is clear from the previous chapter, space technology has been developing very rapidly and its practical applications began within a few years of the launching of the first satellite - the USSR's SPUTNIK - in 1957. Few other technologies have witnessed such a rapid transition from experiment to routine operation and almost no other advanced technology is as widely used. Space technology is now used in a wide variety of fields and its current applications include communications, broadcasting, meteorology, remote sensing, navigation and geodesy. Space manufacturing and space biology are fields in which some experimentation is already under way; space power systems have been studied and analysed in depth, and even space settlements have been discussed. Given the rate at which space technology has been advancing, there will soon be no technological constraint to the realization of these concepts. The actual application of space technology, however, has to be constrained by other considerations, including especially the costs and benefits. This chapter discusses space applications from this perspective of beneficial use.

### 1. Telecommunications

144. Of all the applications of space technology, the most widely used - and the one that has become the most routinely operational - is satellite communication. While its first uses in 1960 were for intercontinental communication, satellites are being used by a growing number of countries for domestic communication also. Satellites for international communication are operated (since 1964) by the International Telecommunications Satellite Organization (INTELSAT) and (since 1971) by the International System and Organization of Space Communications (INTERSPUTNIK)(for brief descriptions see chap. III A). INTELSAT also leases capacity on its satellites for domestic use. Some countries have their own operational domestic satellite communications systems (Canada, Indonesia, USSR, and United States), while many others have plans to set up such systems soon.

145. Once a communications satellite is in orbit, communication can be established beween any two places within its service area by setting up earth stations. Thus, for developing countries with poor communication infrastructure and with little investment in conventional terrestrial systems, satellite communication could be a big boon and therefore emphasis should be given to the needs of such countries.

146. Communication plays a key role in development, to the extent that it transfers information, data and ideas. It is one of the key infrastructure elements for social and economic development. While broadcasting does have greater reach and often more impact, the two-way nature of telecommunications engenders participation and involvement. For historical reasons, telecommunications is, almost everywhere, organized as a self-supporting and/or revenue-earning activity. As a result, even when rapid expansion of telcommunications has taken place, it has been inevitably in the heavy traffic

areas. Thus, in many developing countries it is easier to make an international call rather than an inter-city one, and easier to call another city in the country than a small town only a few miles away. In part, this is due to satellite communication and its distance-insensitivity, but mainly it is due to a lack of adequate resources, technical expertise and capital to establish an extensive and reliable infrastructure. It is therefore desirable that developing countries examine in detail the importance of communications, espcially to and from rural areas, as an integral element of development and that studies to this end be undertaken by appropriate agencies of the United Nations system - especially ITU , which has already initiated work in this field, and UNESCO which has recently established an International Programme for Development of Communication (IPDC). It is also necessary that funding institutions recognize communication as an essential infrastructure for development and provide adequate funding for systems (national and regional) that aim to strengthen this infrastructure.

147. Despite the many advantages and the tremendous possibilitites offered by satellites, their use is not necessarily always advantageous or beneficial. There are situations in which space communication may not be the best solution and may, in fact, be needlessly expensive. Even where space communication is used, an optimum mix and an integration of various systems is necessary. All countries - and developing countries in particular - should therefore undertake careful studies to determine the best approach to their communication needs. Where necessary, the United Nations system should provide assistance in the conduct of such studies.

148. Even when the use of a satellite seems optimal, it is necessary that the matching infrastructure be in place on the ground. Experience indicates that satellite capacity is often under-utilized due to poor co-ordination and planning on the ground, especially with regard to interfaces - both equipment and organizational - between the space element (including the earth stations) and the rest of the system. This aspect - equipment interfaces, appropriate modems, organizational co-ordination, etc. - therefore needs special attention.

149. Technological advances have made it possible to use small and inexpensive earth terminals. These are especially important for rural communication, where the need is generally for only a small number of channels. CCIR of ITU has for many years been studying low-capacity earth stations and associated satellite systems. A recently-completed prefeasibility study by ITU and the Federal Republic of Germany on the use of modern telecommunication technology for integrated rural development in Africa has recommended, as one option, a specially designed satellite system and small earth stations. However, most existing systems are not specially designed for communication with small terminals; instead, they are basically designed for carrying the high-density inter-city traffic and therefore their use for rural communication is "sub-optimal." For promoting rural communication, it is thus necessary that systems be specially designed for rural communication. Specifically:

(a) The satellite should be capable of receiving low-power signals;

(b) The satellite should transmit high equivalent isotropically radiated power (EIRP), concentrated in the area of interest;

(c) On-board regeneration and spacecraft (on-board) switching should be incorporated, if feasible;

(d) The ground terminals should be as inexpensive as possible and be capable of operating from renewable power sources or standard batteries.

150. [One important problem in this regard is the flux density limitations in the 6 and 4 GHz satellite communication bands which necessitate the use of larger terminals than are really essential. For historical reasons, this is the band in which technological advances have combined with large-scale production to make for lower costs . Therefore, if the flux density limitations were [removed or] relaxed, it would be possible to produce, quickly, low-cost terminals for rural use. While any general relaxation of the limitations would be difficult because it is a band shared with existing terrestrial radio-links, it is suggested that ITU examine the feasibility of relaxing the flux density limitations in certain geographical regions [and/or in at least a part of this band for special rural communications use.] In this context, it seems desirable that developed countries shift their satellite communication systems to a different frequency band (e.g., 11/14 GHz), leaving the 4/6 GHz band basically for use by developing countries. Developed countries should also be encouraged to shift their high-density and transoceanic traffic to submarine cable or fibre-optic systems, thereby decreasing the pressure on the radio frequency spectrum and on the GSO. [At the same time, ITU might also examine whether portions of the VHF and UHF bands could be used for satellite-based rural communications, espcially in areas and/or bands where there may be no problems of interference with existing terrestrial services. Their use on an experimental basis in the South Pacific and elsewhere has indicated great potential for low-cost, low-traffic use.]]

[Deletion of the complete para. has been suggested.]

151. For a vast number of purposes, instantaneous two-way communication is far from essential. What is required - especially in rural areas - is a way of sending and receiving messages and data quickly, reliably, easily and economically between a number of different points. Existing systems - both conventional and space - do not cater to these needs and requirements, where they do, it is only in an inefficient, slow and/or expensive manner. It now seems feasible that fairly simple satellite-based systems may meet these needs. It is even possible that in some cases a low-orbit satellite system (involving an inexpensive launch and relatively inexpensive satellite) combined with microprocessor/computer technology could adequately satisfy these needs by serving as a "travelling electronic postman". It is therefore recommended that a study involving these concepts be carried out by the United Nations, in association with appropriate specialised agencies e.g., ITU and UNESCO, for one developing country to provide an example of a feasible system.

### 2. Mobile communications

152. Mobile telecommunications are used for differrent purposes and new services are being considered. In this context it can be noted that INMARSAT is studying an integrated mobile communications system by using satellites. Such an integrated system could, in the long term, lead to a reduction of costs for terminals used on ships, aircraft or on land.

### 3. Land-mobile communications

153. Mobile communications systems for use on land are now being planned in some countries and are being considered by INMARSAT as well. Such systems would not only be of use for normal mobile communications, but would also be especially useful for disaster relief and emergency operations. Being basically designed for use with simple terminals which need only a few channels each, such systems could clearly be modified to serve rural communications - where the needs are somewhat similar. This possibility merits examination, and countries and agencies planning mobile communications systems using satellites should be encouraged to look at the feasibility of using the same system for rural communication in developing countries.

154. The INMARSAT Council has decided that, in the context of its research and development programme, space segment capacity would be made available for general mobile experiments and pre-operational trials on a pre-emptible basis. Such use of the INMARSAT space segment would be without prejudice to any institutional arrangements and without commitment to provide operational services. INMARRSAT is also giving consideration to the possibile use of the INMARSAT space segment for emergency relief operations on land with transportable earth stations approved and commissioned in accordance with the appropriate INMARSAT standards and procedures.

### 4. Maritime communication

155. Maritime communication is now an established space application and INMARSAT is the international agency that will operate the system for international maritime communication. Maritime communication via satellite will not only result in quicker and more reliable communication, but will also lead to greater safety at sea and quicker response to emergencies. The proposed Future Global Maritime Distress and Safety System being evolved by IMCO and INMARSAT would be an important contribution to safety at sea and deserves the continuing support of all nations. While the present importance of maritime satellite communication is necessarily limited in most developing countries, its role is bound to grow with time as maritime developing nations expand their trading and shipping fleet and - later - their marine resources exploitation activities. However, in order to derive the full benefits of space technology for maritime communication, the efforts of INMARSAT (with ITU and IMCO) to develop smaller and quite inexpensive ship terminals for a broad range of communications, distress and safety applications should be continued. Necessary changes in the over-all system design should be examined by INMARSAT, particularly from the

point of view of enabling greater usage by developing countries. In this context, appropriate United Nations agencies should provide assistance, on request, for the conduct of studies aimed at assessing the communication requirements.

156. In certain circumstances, the primary requirement is for one-way communication - transmission of storm warnings or other messages - and for reception of a beacon to facilitate search and rescue missions, if required. These are vital for maritime safety, and INMARSAT is actively studying possible methods for early implementation of one-way (broadcast) transmissions of weather forecasts, storm warnings, navigational warnings and other safety messages, for reception by means of simple and inexpensive broadcast receivers suitable for all classes of ships. INMARSAT is also co-operating with ITU and IMCO in an experimental programme where emergency position-indicating radio beacons (EPIRE) capable of immediate distress alerts to shore will be tested. Experiments and demonstrations will be conducted in 1982 - 1983 by the Federal Republic of Germany, Japan, Norway, the United Kingdom, USSR and the United States using INMARSAT satellites and in conjunction with shore stations operated by INMARSAT member states and ESA.

### 5. Aeronautical communication

157. While aeronautical communication via satellites has been experimented with, there is as yet no operational system in this field. INMARSAT is examining the possibility of providing this service on its future spacecraft. It is possible that such a service may be operational by the end of the decade. ICAO is also engaged in studying the needs and posibilities of such a service. In view of the potential importance of aeronautical communication - for both routine operations and safety - it is important that such studies be continued.

### 6. Satellite-to-satellite links

158. Another important emerging application in the communications field is satellite-to-satellite links. The United States Tracking and Data Relay Satellite System is the first such system that will be used, among other things, for relay of remote sensing data (from LANDSAT-D) to receiving stations. Such a system reduces the minimum number of stations required for receiving world-wide data from orbiting satellites. Such satellites could also be used for linking one communication satellite to another, thus enabling a signal to be sent around the globe without having to go through multiple earth-satellite hops. The linking of national satellites with international ones would enable calls from the interior of the particular country to be made to international destinations without the unacceptable delay associated in going through two earth-to-satellite hops.

### 7. Future communications applications

159. The advanced technologies mentioned above, in addition to others like beam shaping, multibeam antennas, frequency reuse, on-board satellite

switching, use of higher frequencies and use of new communication techniques, will result in a continuing revolution in the field of satellite communications. Concepts like satellite clusters and large, very high-power communication satellites are also likely to be realized soon. Among other things, these developments could make feasible such ideas as pocket-size transceivers through which one could communicate with another individual anywhere else on earth. Like most technological possibilities, these developments in space communication could be used in a wasteful manner of little benefit to most nations, or they could be directed so as to provide very substantial benefit to all nations. They could have considerable social and economic implications, and their beneficial uses would need appropriate organizational arrangements. While some of these developments were in the realm of science fiction only a few years ago, there is now little doubt about their technological feasibility. It is therefore recommended that the United Nations system examine the implications and potentials of these developments, especially for developing countries.

### 8. Satellite broadcasting

160. Reception of satellite-relayed television programmes by specially augmented television receivers is now a well-proven application. Though the USSR is at present the only country with an operational system, other countries - including Canada, Japan, India, the United States and, in a joint venture, the Federal Republic of Germany and France - have carried out experiments and many are now planning operational domestic systems. This is obviously an application with tremendous possibilities, especially for education - in the broadest sense of the term - and as a means of accelerating development.

161. Operational use of the 12 GHz Broadcast Satellite Service is likely to be introduced soon. This, together with the future utilization of the 30/20 GHz band, will make it possible to use receivers having parabolic antennae of the order of one meter diameter and possibly even smaller. Advances in low-noise receivers have also made possible comparatively small (3 to 4 meter antenna), low-cost systems for reception of television broadcasts in the 4 GHz band. These are widely used for television networking in North America.

162. The issues connected with the use of satellites for education are discussed in greater detail in section E below.

### 9. Remote sensing

163. Remote sensing has become an increasingly important application of space technology even though there is as yet no formally "operational" system. Many countries - including some developing countries - have been involved in either data analysis or both data reception and analysis. While the LANDSAT satellites of the United States have been the most widely used, other countries - including the USSR, India and jointly by the USSR and Bulgaria - have also used their own remote sensing satellites. Data has been collected in various bands of the electro-magnetic spectrum, including visible, infra-red, and microwave; and both active and passive sensors have been used.

164. Remote sensing applications are most effective when data acquisition and analysis are carried out in a problem-oriented manner. Ideally, remote sensing data should be collected at different altitudes with varying degree of detail and, if possible, at different times (multistage and multitemporal data acquisition). Satellite remote sensing data are generally no substitute for more detailed data from aerial remote sensing missions. But they are extremely useful for small-scale reconnaissance mapping of large areas. One satellite image typically covers an area that would require a photo-mosaic composed of several thousand aerial photos. The synoptic nature and homogeneity of satellite remote sensing imagery is also very suitable for the delimitation of large-scale homogeneous associations of features representing, e.g., certain types of land use, ground cover, drainage patterns, morphology, etc. This eases the incorporation of details recognizable in aerial remote sensing data into the regional context and allows, among other things, the cost and time-saving expansion of detailed local information from ground and aerial surveys to much larger areas.

165. With regard to analysis and interpretation of remote sensing data, one has to note that these images are instantaneous representations of the surface appearance of a vast number of different objects in their complex unity and relatedness. Discipline-specific information has to be filtered out, requiring an interdisciplinary understanding of the mutual relationship of these different forms and patterns and their radiometric-spectral appearance. Therefore, visual image analysis by an experienced photo-interpreter who is a spcialist in a given field is generally superior to automatic image analysis in instances where the thrust of the interpretation effort lies in the recognition and complex evaluation of geometric-structural features and patterns. Much of this can be done by using very simple and inexpensive equipment and techniques (see chap. I, para. 102). On the other hand, the full resolution of radiometric-spectral feature contrasts, their quantitative evaluation, statistical analysis and automatic classification require the application of digital methods of image data analysis. Digital image pre-processing aimed at feature enhancement can also be extremely useful for subsequent visual interpretation. Therefore, the use of interactive hybrid image analysis systems permits optimal man-computer "co-operation" and - depending on the specific task - fully exploits the specific advantages of both analog-visual and digital image analysis and intepretation. However, before embarking on major investments in expensive equipment - requiring also specially-trained personnel for effective utilisation and maintenance - the need-condition context should be carefully analysed.

166. Satellite remote sensing has, a priori, planetary dimensions. The synoptic view and the possibility of frequent repetitive coverage of large and even inaccessible areas make, for the first time, regional and global monitoring of renewable natural resources and changing environmental pheomena technically feasible and economically attractive. The long-term future of satellite remote sensing lies, therefore, in its operational utilization for effective management of renewable resources and the monitoring of man's environment. This potential is still far from being fully exploited, partly due to the large time lag between the acquisition of data and their availability

to the user. Effective application requires rapid, and preferably direct, access by countries to data of their territories. "User-friendly" satellites that can work with simple, inexpensive ground equipment would greatly facilitate this, and their development needs encouragement. At the same time, sophisticated sensor systems transmitting very high data rates may need large, expensive ground reception and data processing facilities. Since most countries may not be able to afford such investments, the alternative of central or regional facilities might be considered, possibly in conjunction with a system of distribution of the processed data to simple, low-cost user terminals.

167. One major obstacle for remote sensing in the optical part of the spectrum (visible and infra-red) is that cloud cover cannot be penetrated. Since about 50 per cent cloud cover is typical for most countries, developed and developing countries alike, a need for high-resolution all-weather satellite radar has repeatedly been expressed and a few countries are pursuing programmes aimed at establishing such systems within this decade. From an applications point of view, it must, however, be mentioned that both data acquisition and processing from such systems as well as the proper analysis of radar data for topographic and thematic interpretation pose significant problems. Currently planned systems will - for numerous technical and economic reasons - use only a single-frequency synthetic aperture radar. In the case of vegetation studies, however, good results would require multi-frequency radar. Generally, much research is still needed in order to make efficient use of imaging radar data for thematic interpretation. Their main potential is currently still in the field of geologic-geomorphologic investigations, in particular in regions wih heavy cloud cover.

168. Remote sensing has the potential to partially replace, rationalize, intensify and/or supplement conventional survey and resource management systems. Although much needs still to be done to fully exploit this potential, data obtained by remote sensing satellites and often unobtainable by any other means, complemented with other collateral data and "ground truth" have already been widely applied with great success and significant benefits in many countries. While developed countries use this data mainly for change detection and updating of existing information, many developing countries still use it, in the first instance, to derive primary basic information on land cover and land use, hydrology, topography, geological structures, etc.

169. Remote sensing applications aimed at topographic and first order thematic mapping using methods of visual photo-interpretation are relatively simple to accomplish by trained interpreters and do not require major research efforts and investments in ground hardware. Their results are in most cases self-evident and can easily be combined with conventional data and integrated into existing traditional information systems or data banks. This type of application is, therefore, still dominant, in particular in developing countries.

170. New potentials of remote sensing lie in applications aimed at the solution of complex survey and monitoring tasks such as agro-meteorological crop-yield prediction, early detection of potential breeding sites of desert

Accordingly, the current discussions on this in the Committee on the Peaceful Uses of Outer Space (COPUOS) should be completed expeditiously.

## 10. Meteorology

173. Meteorology has been a major field of space application.Various international programmes organized by WMO (see chap. III) have met with considerable success and observations from space are now an integral and important part of weather reporting and forecasting. Satellites are used for the dissemination of processed meteorological data to users all over the world, and also for the collection of data from remote places or mobile platforms through data collection systems. Cloud cover pictures, vertical temperature profiles, sea surface temperatures, sea state, sea-ice, precipitation, snow-cover and a wide variety of other data are collected by a number of meteorological satellites operated by a number of countries. Data is received directly from satellites by many countries - mainly through the automatic picture transmission (APT) system - and indirectly through communication links by many others.

174. The present world-wide system is largely operational and includes close co-operation and co-ordination between satellite operators as well as national meteorological services. Problems of utilization of national space and ground segments, of standardization, acquisition, archiving as well as world-wide exchange of data and their application both for actual weather forecasts as well as in connexion with world-wide or regional research projects are discussed in WMO and the respective activities of States are co-ordinated in the framework of the WMO, WWW and GARP. Access to data from operational meteorological satellites is free, and because many countries have become dependent upon this system, it is necessary to ensure continuity of service. This is especially important for developing countries which do not have independent or alternative sources for much of this data and for whom weather forecasting is directly linked to national prosperity because of their dependence upon rain-fed agriculture.

175. Until now, data from meteorological satellites have mainly been used in synoptic weather forecasting. For numerical forecasting, satellite data collected up to three hours preceeding the starting point of the prediction are generally included without time correction. The large and well-equipped forecasting centres apply the so-called four-dimensional assimilation of satellite data. Satellite derived vertical temperature profiles are still - because of limitations in accuracy as compared to *in situ* measurements - useful only over areas with a lack of atmospheric air *in situ* data. The methodology for operational determination of atmospheric humidity and wind fields from satellite measurements as well as the world-wide availability of data on humidity cannot yet fully satisfy practical requirements for advanced numerical weather forecasts. More research and operational efforts in this direction are still required.

176. Geostationary meteorological satellites with their capability of virtually continuous observation of cloud patterns over major parts of the globe have proved to be extremely useful for early detection and tracking of

locust, detailed classification of land cover and land use, water and air quality monitoring, identification, classification and quantification of hydrothermally altered rock formations, reliable prediction of snow-melt run-off for a given water shed area, etc. A successful solution of such complex tasks necessitates the use of satellite remote sensing data in conjunction with extensive "ground truth" and other complementary data and information. It also requires major research efforts and, frequently, extensive use of sophisticated computer hardware and software for data analysis and quantitative modelling of the phenomena and processes. Such applications are - initial promising results notwithstanding - still in an experimental stage. This is the more so, since operational data availability with the required sensor parameters and repetitivity of data collection is not yet assured by current systems. The same applies for all-weather remote sensing and marine observations. Oceanographic satellites have been so far purely experimental. Operational applications in this field are likely to take a few more years.

171. Recent analyses indicate that the largest benefits of satellite remote sensing might be expected in the area of agriculture followed by applications for land-use planning and water resources management. But it should be kept in mind that the relative benefits which one can derive from different types of applications depend both on the technical parameters of available remote sensing systems and systems alternatives as well as on the actual status of knowledge about one's country's resources, their relative abundance or economic relevance as well as on environmental and other conditions. Cost-benefit assessments of satellite remote sensing, too, make sense only with respect to the specific problems to be solved paying due regard to local conditions, needs, systems specifications, cost and timeliness of data acquisition, and available alternatives and recognizing that only part of these benefits may be quantifiable in economic terms. Each country, therefore, has to make its own unique cost-benefit assessment and decisions before embarking on large-scale remote sensing applications and major investments. In this respect, it is likely that many developing countries may have similar needs and the United Nations system and interested countries should:

(a) Take steps to study these needs and assess appropriate remote sensing systems to meet them; and

(b) Encourage dialogues between users/potential users and designers/producers of satellite systems to see how and to what extent user needs can be met.

172. Satellite-acquired data, combined with ground observations, may in future make possible accurate crop predictions, location of mineral and hydrocarbon resources, etc. through better resolution, use of all-weather sensors and a better understanding of the science of remote sensing. A possible situation in which data is not available to the sensed State but is available for commercial and other forms of exploitation by another country has been a cause for concern to a number of countries. It is therefore important to reach agreement on principles governing satellite remote sensing.

severe tropical storms. The maximum wind speed of hurricanes and cyclones can be derived from correlation between wind speed, the phenomenological type of the cloud spiral and its diameter as inferred from the satellite imagery. It is hoped that in the future satellite-based prediction of the severity and path of these storms might be possible up to 48 hours in advance with sufficient accuracy to facilitate preventive actions. WMO runs a special Tropical Cyclone Programme (TCP) in which the use of meteorological satellites is a key element. WMO reports regularly on the progress made in implementing the programme to the United Nations Committee on the Peaceful Uses of Outer Space.

177. Meteorological satellite imagery has also been used in experimental applications for flood prediction caused by snow melt run-off. Although the spatial resolution of meteorological satellites is relatively coarse as compared to resource satellite sensors, the estimates of snow cover, if the area is large enough, are still sufficiently good, and the advantage of much more frequent repetitive coverage offsets by far the resolution disadvantage. This is particularly important because the greatest danger of flooding exists in periods of rapid melting - and consequently snow cover change - in connexion with high insulation and surface temperature or rainfall. Both factors can be measured or at least inferred from satellite data.

178. Estimation of rainfall through monitoring of cloud patterns in both the visible and thermal infra-red range and the use of correlations between rainfall, brightness and radiation temperature of cloud tops in satellite imagery seem to hold promise for evaluating regional crop productivity, particularly for areas in which water availability is the controlling factor. During the NASA Large Area Crop Inventory Experiment (LACIE), rather good early wheat production estimates were achieved by combined use of LANDSAT remote sensing data (for acreage estimates) and data from meteorological satellites (for estimates of average monthly soil temperatures, precipitation and - in some instances - also potential evapotranspiration as a measure of plant stress). However, this was done only over areas with large fields and low crop variety. FAO has carried out several regional studies using both data from meteorological and remote sensing satellites for early detection of potential breeding sites of migratory desert locust. Meteorological as well as remote sensing satellites also hold promise for monitoring desertification phenomena and both have been used in joint regional studies by the Food and Agriculture Organization, the United Nations Environment Programme, UNESCO and WMO and as part of the Global Environment Monitoring System (GEMS). In the Soviet Union, data from Meteor satellites are operationally used in conjunction with aerial surveys and ground truth collection for regular spring and fall estimates of biomass productivity and carrying capacity of large rangeland areas in Central Asia.

179. New experimental sensors of high radiometric and spectral resolution are also used in studies for large-scale air and water pollution monitoring and in experiments to determine the concentration of chlorophyll from quantitative measurements of "ocean color" in several spectral bands, but a good deal of basic research remains to be done before these applications can be used operationally. In any event, it seems clear that satellite systems will not be

a substitute but rather a complement to in situ measurement of environmental pollutants. The main potential of satellites lies in monitoring the extent, movement and dispersion of large pollution plumes. For accurate source detection and identification, the spatial resolution of meteorological satellites is normally not sufficient. On the other hand, high resolution satellites do not generally meet the repetitivity requirements for pollution monitoring.

180. As already mentioned in chap. I, para. 85, meteorological satellites are also widely used in order to collect and distribute a great variety of environmental data acquired by remotely located, manned or unmanned data collection platforms (DCPs) on land, at sea or in the atmosphere. DCPs can, amongst other things, provide part of the independent meteorological in situ ground data needed for calibration/interpretation of remotely sensed data. The two types of data are complementary and should, therefore, be used jointly wherever possible. DCPs are also used to observe changes in seismic activity (event counters), to make river guage and flow measurements and to monitor sea level changes that might be connected with earthquake-generated tsunami waves. The DCP data relay capability of meteorological satellites is playing an ever-increasing role in the establishment of satellite-based early warning systems for natural disasters. Requests for medical or other kind of help could also be relayed using DCP transmitters.

## 11. Navigation and geodesy

181. Navigation and geodesy are less prominent - but nevertheless important - applications of space technology. Methodologies, major satellite systems, and the more scientifically oriented concepts and results of geodetic applications have been dealt with in chapter I, section F. In the following paragraphs, emphasis will be laid on applications of navigation satellites.

182. Navigation has always been of great importance to man, and while navigational errors have sometimes led to unexpected discoveries, they have more frequently led to disaster. In the modern world, accurate navigation is becoming increasingly important not only for safety, at sea and in the air, but also for optimizing steadily growing traffic flows and minimizing fuel consumption through appropriate routing. Reliable position determination is also needed for a variety of other economic activities - e.g., off-shore oil drilling and sea-bed mining - or scientific studies related to geodesy, plate tectonics, geodynamics, etc. While some of the scientific studies require very accurate geodetic measurements using satellite laser radar or very long baseline interferometry, almost all safety and economic activities can effectively be carried out by using satellite navigation based on Doppler measurements.

183. One proposed safety application is the experimental SARSAT (jointly by Canada, France, and the United States) and the Space System Searching for Vessels and Aircraft in Distress (COSPAS) (USSR) systems for search and rescue. Both use radio beacons transmitting distress signals to orbiting satellites which relay the signals to a ground station for processing. The two systems are

compatible, enabling quicker and better response to distress signals. Other experiments will be carried out by member-administrations of ITU using the INMARSAT space segment (see para.156). EPIRB equipment used for these tests will be capable of providing an immediate distress alert with transmission of the vessel's position to shore-based SAR authorities. In view of the importance and the humanitarian nature of these systems, it is desirable that the present co-operation be continued and efforts be made to evolve a world-wide operational search and rescue system as soon as possible.

184. Navigation satellite systems are operated by both the USSR and the United States. The Tsikada satellites of the USSR serve several hundred ships, off-shore drilling rigs and floating bases. The United States Navy Navigation Satellite System (NNSS) has been used by many countries for many years for both navigation and geodesy. This is now to be phased out and to be replaced by the Global Positioning System (GPS), (see chap. I, para.120). This will have the capability of far greater accuracy for both position location and navigation on the ground, at sea and in the air. The system will operate at two different levels of accuracy. It is not yet clear to what extent the United States will permit access by other countries, but it is hoped that the GPS system will be made available to users. However, a long-term answer to the needs of the many actual and potential user countries needs to be devised. A single world-wide system seems very attractive since it would ensure compatibility and yet require a much lower investment from interested countries because the space segment costs could be shared (see also section C below).

185. Position location of "ground control points" is also useful for processing of remote sensing data. These are prominent features whose exact location is known (possibly by satellite geodesy) and which are then used for "correcting" the image to obtain high precision data products.

186. The immediate economic relevance - and overall importance - of satellite navigation and geodesy highlight the need for providing continuity and assured access to such systems by all countries. In its basic form, the ground equipment required for position-location (a georeceiver and a computer for data processing) is not very expensive or sophisticated and is within the reach of most countries. Thus, this is an application which can be taken up without great difficulty by all countries which have need for such uses. This is another reason to move ahead quickly and establish a mechanism for an ongoing international satellite geodesy/navigation system.

## 12. Future applications

187. With further advances in space technology, new applications seem feasible. Among the major ones being studied at present are manufacturing or processing in space, and space power systems. The operational applications of these are probably many years away, but it is already time to examine their relevance and their implications. Their possible biiological, ecolcgical and radio-frequency interference impacts must therefore be studied and identified by ITU and other United Nations agencies with the necessary information to decide on them. Some of these issues are examined in greater depth in section I below.

## B. Choices and difficulties in the use of space technology

### 1. Choices

188. Space technology now spans a vast range of complexity from fairly common and comparatively simple APT receiving stations to extremely complicated fully-automated space probes. It also encompasses equipment whose costs range from a few hundred dollars - for a television direct reception system, for example - to many millions of dollars. The investments required to develop and produce such equipment differ by many orders of magnitude, as do the infrastructure and technical skills involved. The variety of space applications now feasible, though not as wide-ranging, is also quite substantial. It is within this almost bewildering array of possibilities that a country must make choices about what applications and which technologies it wishes to pursue. Clearly, the choices must be determined by:

(a) the needs of the country;

(b) its priorities;

(c) the feasibility of meeting these needs and priorities through the use of space technology with due regard to other countries' needs;

(d) The financial resources, the industrial infrastructure and the tecnological capabilities of the country;

(e) The availability of matching scientific and application-oriented as well as managerial and decision-making infrastructure and human resources required for effective utilization of data and of the information derived therefrom;

(f) Recognition of the rights of other countries to utilize space technology at a later stage.

189. It is therefore obvious that there can be no fixed formulae of universal validity. It is equally evident that costs and benefits of space applications also will vary from situation to situation and from country to country. Thus, each choice of a space application by a country has to be unique: a decision based upon the parameters of its particular context. This requires that each country carry out studies regarding costs and benefits before deciding upon the adoption of a particular application. Such studies should take into account not merely the economic aspects, but also technical, environmental and social effects that may result from the use of space technology. Many of the developing countries may not themselves have all the expertise necessary for such interdisciplinary studies. In this case it would be advisable to consult with other developing or developed countries which have worked on these problems and have relevant expertise, or to seek advice from appropriate United Nations bodies and agencies through established mechanisms.

190. In many cases, assistance may not be required for basic decisions regarding whether to get into a specific application; rather, it may be required for choices of systems, type of equipment and selection of the most suitable methodological approach to tackle the problem in question. The latter is a particularly important element, because it has a significant bearing on the choice of the most appropriate system or instrumentation and thus also determines other parameters such as cost, organizational set-up, degree of self-reliance, extent of indigenous participation possible, etc. The United Nations system should - on request - provide such assistance to help countries make appropriate choices.

191. In deciding upon and implementing a space application, there is a whole hierarchy of possibilities ranging from problem analysis and systems studies through fabrication of ground hardware to the development and launch of spacecraft and setting up and running an effective user-oriented ground segment with all its ramifications. The level and extent of indigenous effort undertaken by a country clearly depends on the criteria outlined in para. 188 above. Thus, countries at different levels of development would be in a position to undertake different magnitudes of indigenous efforts. All possibilities for mutually beneficial co-operation between different countries by undertaking complementary efforts in this respect should be fully exploited (see chap. III D for an elaboration on this).

192. Other important aspects with regard to the choices for utilizing space technology include:

(a) While the most sophisticated technology is frequently tailored for multi-purpose utilization, it is not necessarily the most suitable for a given application;

(b) Practical application of space technology requires a great deal more than the mere hardware. These non-hardware elements need to be given much more attention than they usually get;

(c) The "end-links" in any application are of crucial importance and due care must be taken to set these up in good time;

(d) The existence - or use elsewhere - of space technology for a particular application does not automatically imply or prove its universal utility: in a given situation, it is quite possible that a non-space technology may be more suitable;

(e) While considering present applications of space technology, due attention should be paid to combining it with medium and long-term needs.

## 2. Difficulties

193. Most countries - and developing ones in particular - face a number of difficulties with regard to space technology and its efficient utilization. Some of the major problems are identified in the following paragraphs. On the

other hand, these very difficulties might spur innovative approaches, press for needed indigenous educational, scientific-technical, industrial and managerial efforts and thus finally contribute to increased self-reliance and socio-economic advancement. Suggestions on how to overcome some of these major difficulties will be dealt with in sections C and D.

(a) Financial and industrial resources

194. Development, fabrication and operation of space hardware - i.e., launch vehicles and/or satellites - are large-scale ventures requiring a well-developed industrial and scientific-technical infrastructure and substantial investment in facilities and equipment that most developing countries do not have or cannot afford purely on their own. Also, most space applications include the use of fairly sophisticated equipment which - if not manufactured in the country itself - would need to be acquired from abroad. The investment proportions in ground and space hardware would very much depend on the type of application and on whether the space segment would have to be bought (inclusive of launch cost) or leased, in full or on a cost-sharing basis, or whether access to it or its data is granted free or at nominal cost.

195. Decisions to use space technology should be based on a proper "needs-conditions-alternatives" assessment, and, if possible, also be backed up by positive results of a pilot or demonstration project, thus assuring that there will be a return on this investment in terms of a significant contribution to socio-economic advancement and to the development of indigenous industrial as well as scientific-technical capabilities. However, space applications do have the potential to make significant economic contributions, and expenditures in this field should be looked upon as capital investments on which there will be a return. Thus, while financial support for such projects through bilateral or multilateral financing agencies is important, countries should themselves strive to raise internally at least part of the finances required.

(b) Human resources

196. Development of space technology, as for any other new technology, requires a strong base of high-calibre manpower: scientists, technologists and technicians familiar either with space technology itself or with related technologies - especially electronics, computers, etc. But space technology is only a tool to a higher end. Its effective use also requires a large number of adequately trained personnel in the respective application areas and a fair number of knowledgeable people at the decision-making level who are aware of the potential contribution of space derived data, information and services to development and capable of efficiently integrating them into the decision-making process. Most developing countries lack well-trained people at all these different levels; however, almost all do have at least small nuclei which need to be identified and expanded through suitably tailored national and international efforts on training and education (see para. 212 below and A/CONF.101/BP/9). There is need for both national and international action in this field (see paras. 237-240 below and chap.III, para. 377).

197. The use of space technology in developing countries, especially in connexion with the import of equipment (see para. 198), frequently entails the need for hiring foreign expert services at considerable cost in foreign exchange. In most cases, development agencies too insist on providing experts as part of a total aid package, although similar expertise might be available in the country itself. While the asistance of foreign experts can - in some cases - be of great help or even be indispensable, it is obvious at the same time, that total reliance on such external experts discourages development of indigenous expertise in the respective fields and impedes self-reliance. Identification and maximum utilization of already existing expertise in one's own country, or in other developing countries with similar conditions, together with a systematic development of knowledge and abilities required, are important pre-conditions for effective development. External assistance can of course be useful, but a provision of experts should not be a mandatory part of any aid package provided by international agencies.

(c) Equipment and its suitability

198. Space technology applications in developing countries generally require the import of costly equipment. This may be a major obstacle to the use of space technology, especially by developing countries facing severe balance-of-payments problems. However, it is true that imported equipment is generally more sophisticated and has a proven record. Nonetheless, some basic questions have to be asked and points to be considered in this regard:

(i) Is the sophistication really necessary to meet the particular needs? (In many cases, it will be found that it is not).

(ii) Does imported equipment, which entails the problem of spares and servicing, pose serious difficulties under the country's economic and logistic conditions?

(iii) Is imported equipment suitable for the developing country's physical (temperature, dust, humidity, etc.) or cultural environment (way of operating equipment, etc.)?

(iv) Although building equipment indigenously might be "risky", is it not an essential pre-condition to the development of an indigenous technological base? Since this "unproven" equipment will almost certainly not be used first by any other country, the opportunity to prove, field-test and - if necessary - improve it, must be provided by the country in which it is developed.

199. The risks in using a particular piece of unproven indigenous equipment instead of a standard foreign item have obviously to be assessed and weighed by each country and compared with the short and long-term benefits. A great deal depends on the ideology, values and development strategy of a country. However, in order for each country - however small or economically poor - to have some element of technological autonomy, it is necessary that due encouragement be provided to indigenous technological development.

### (d) Transfer of technology

200. In some cases, the difficulty in the use of indigenous capability is not so much a question of the willingness to use such capability, but rather the mechanisms of doing so. For example, the transfer of know-how from research laboratory to industry is not easy. The making of a single unit in a laboratory is quite different from fabricating it in large quantities in an industrial situation. This is a problem of great importance to developing countries in particular, and has implications for fields other than space technology. Countries which desire to engage in the manufacture of various space hardware should, therefore, seek the advice of competent agencies concerning problems of transferring technology from the laboratory to industry and from country to country in the field of space technology. The problems of technology transfer from developed to developing countries are discussed further in section D below.

### (e) Internal co-operation and organization

201. Almost any space application requires the involvement of persons from various fields and sectors, who are inevitably affiliated with different departments, agencies, ministries, institutions or enterprises within a country. Lack of co-ordination and co-operation between these different agencies is often a major problem that hinders the application of space technology and the extraction of its full benefits. In many developing countries the lack of these managerial and organizational structures and of co-operative inputs - rather than insufficient technical manpower - is a major obstacle and bottleneck in the use of technology to accelerate development.

### (f) Continuity, compatibility and complementarity

202. There are many developing countries which, recognizing the potential of space, would like to invest in expensive ground hardware, e.g., for the direct reception and processing of satellite remote sensing data. But a major impediment to this is the inability of some major space segment operators to assure the continuity of services. Another obstacle to broader utilization of existing systems is the fear of many developing countries, including those which have already made substantial investments in ground facilities, that rapid technical developments will force them to frequent and costly upgrading and/or modification of their ground segments in order to cope with increasing satellite sophistication or changes in data formats. Thus, there is need for assured continuity and to bring about - to the extent possible - compatibility and complementarity between various satellite systems. (This is discussed in greater detail in section F below.)

### (g) Availability of data and information

203. Doubts about continued availability of data from space sensors may deter countries without their own space segment from using space technology for various applications since they would feel vulnerable if they use such data on an operational basis. The non-availability of information with regard to

various aspects of space technology and space applications is another serious obstacle to the greater utilization of space technology. Information on costs and benefits, on manpower requirements, on alternatives and new applications, etc. are often not easily or readily accessible. Important information about sources for equipment, experiences of others with the particular application or specific piece of equipment, etc. are also not easy to come by. Much of this information does exist, but its availability is not widely known or access to it is difficult. Often, it is available in a different form or is scattered in different places. A system of locating, collating and providing access to such information would be an invaluable aid to the spread of appropriate space technology - especially in developing nations, for whom information access is a serious problem.

(h) Other difficulties

204. While many of the previous difficulties will be observed in the near term, in the medium and long-term very important potential difficulties could face all countries, in particular developing countries. Necessary steps must therefore be taken which will allow all the countries to use space technologies at economically justified costs.

205. [However, there is another major obstacle to drawing the full benefits from space technology - an obstacle that threatens to grow larger and to make uncertain the prospect of future beneficial applications. Increasing doubts about the inviolability of peaceful space activities will mean a set-back to beneficial applications. Many countries have expressed concern at the dramatic increase in the militarization of space. If space technology is to contribute to man's development as fully as it can, if nations and peoples are not to be denied the fruits of its numerous beneficial applications, this negative trend must be reversed.]

## C. Possibilities and mechanisms for enabling all States to benefit from space technology

206. It has repeatedly been emphasized (see Introduction and para. 147) that space technology is not the solution to all problems and that - depending on the actual situation, needs and resources - conventional means might in many cases be a more suitable answer. Nevertheless, there is little doubt that space technology - in appropriate situations and if properly used - can lead to faster economic growth and quicker over-all development. If, however, it continues to be dominated by a few nations who invest in it, there is a danger that it may result in widening further the chasm between developing and developed nations. At the same time, this very stimulus of space technology has the potential to help the developing countries narrow the gap and to accelerate the process of development along paths of their choice. This, however, requires that all countries be encouraged to participate in various space applications so as to derive the fruits of space technology. All countries, and especially the nations with space capabilities, should take all possible steps to further such universal participation in the benefits of space. The following paragraphs outline a few specific actions that should be taken by countries, as also by the United Nations and other international agencies.

207. Concrete and practical benefits of space emerge mainly from "end-to-end" applications projects. Thus, the real benefits from a remote sensing system come not merely from making and launching a satellite or collecting and re- .ving data; nor from processing and analysing the data. Rather, the practical benefits come only after the analyzed data is given to the user and actually used by him in resource management, cartography, etc. While the earlier steps are obviously necessary and important, their novelty and glamour unfortunately often obscure the later, essential links in the chain which consequently do not get the attention they deserve. Similar examples can be given from meteorology - where the payoff can come only when the forecast actually reaches the individual farmer, for instance; or broadcasting, where it is the content of the broadcast that is as (or more) important than the technical means of transmission.

208. Thus, it is clear that countries without any "space" activity can not only derive benefits from space technology, but can actually participate in an important element of space applications - viz., the final utilization of the data. Clearly, in remote sensing this is possible only if all countries obtain the data collected over their territory at reasonable costs.

209. However, the use of such data - even analysed information - needs mechanisms and organizations in the country concerned which can ensure its proper dissemination and utilization. The experience of a number of countries has indicated that this is no easy matter; further, social, cultural and other differences make it difficult to transfer successful models, even when they do exist. Thus, there is here a challenge for each country - whether developed or developing - to experiment, develop and evolve a model for its own situation. In order to derive fully the benefits of various space applications, countries uld give priority to developing such information utilization mechanisms, appropriate to their needs and situation. Since this requires neither sophisticated technology nor large financial resources, this activity - essential for deriving the benefits of space applications - can be taken up even by small and developing nations.

210. In the context of data analysis, it is important to note that a crucial element in machine analysis is the software or computer proramnes. Developing countries, with their abundance of manpower, could consider assigning special priority to this "labour-intensive" activity by giving importance to the training of computer programmers. However, appropriate hardware is also necessary, and this requires fairly substantial investments. Therefore, this high "value-added" activity may be suitable only for some countries. It is also important to note that there is concern about continued availability of data (see para. 203). While assurances about continued data availability are desirable and would encourage many countries to proceed with investments and operational uses, there is also a need for easy and quick access to data. It is therefore recommended that existing international satellite data banks (including especially those of the Remote Sensing Centre of FAO and of the Remote Sensing Unit in the United Nations Department of Technical Co-operation for Development)be strengthened and expanded. Other data banks at national and international level should also provide access to data on a reasonable basis.

1. With the very substantial - and rapidly increasing - volume of satellite-acquired data and the growing number of data banks of specialized or general nature, there is a growing need felt by users to have essential information concerning these data banks. This information could be obtained through a central clearing-house that can link needs with sources. It would also provide information on availability and location of satellite-acquired data in the various data banks, and information on how to have access to them. It is recommended that such an information centre be set up in the United Nations (see chap. III, para. 425).

212. There is sometimes a notion that space technology is an altogether new discipline, education and training for which can be done only in new, specialized centres. In fact, space technology does not involve any "new" disciplines, but is mainly a transdisciplinary combination of well-established fields, including physics, astronomy, chemistry, mathematics, electronics, various engineering disciplines (mechanical, structural, chemical), etc. Many developing countries do have at least some infrastructure in these fields, and can therefore - with only marginal help - develop a core of people who understand and can, in the first instance, make decisions regarding space technology and applications relevant to their country. Even if a country does not plan to embark immediately on development of space technology, it will have before it a range of choices with regard to various applications: should it have an (another) earth station for international communications; what type and from which manufacturer; should it get involved in remote sensing data processing; what meteorological information should it receive directly from satellites - and a host of other such questions will have to be decided upon. Meanwhile, it is likely to experience pressure from over-enthusiastic suppliers, vested interests of various kinds, and others. In such a situation, it is obviously essential that all countries have at least a nucleus of experts who can make knowledgeable decisions in the field of space technology. Already existing nuclei need to be identified and organized, and the necessary institutions and conditions for expanding them rapidly must be created. Where necessary the United Nations and its specialized agencies could help countries to develop this expertise by arranging fellowships for training and visits to appropriate centres (see section D below). In the short-term, the United Nations system should utilize and improve existing mechanisms to provide - on request - advice to countries regarding choice of systems, equipment, etc.

213. The importance of trained manpower at all levels is recognized by all countries embarking on development and use of space technology (see also para. 196). Besides the need for technologists and application specialists there is also a need for developing a cadre of technical managers for the planning and speedy implementation of technological as well as application programmes. Equally important is that - with the growing role of technology - countries also induct appropriate technologists and application-oriented specialists from various disciplines into the administration or government decision-making machinery. This will certainly enable countries to make better choices and to derive greater benefits from space technology through more efficient and knowledgeable ways of integrating the results and services from space applications into the decision-making process. Popularization of space technology

and its potential contribution to socio-economic advancement can help to create his broad awareness at all levels of a society. The United Nations, through its appropriate bodies, might play an important role in this respect.

214. However, adequately trained manpower is - by itself - not sufficient. The organization of this manpower into productive teams through appropriate institutional frameworks and the overall mechanisms for co-ordination and co-operation within a country are equally important. Especially in an applications project, there is a need for considerable and close co-ordination between a wide variety of agencies. Such co-ordination has taken different forms in various situations: committees, joint management, a focal agency, etc. While the precise mechanisms of co-ordination will vary from country to country - dependent as they are on social, economic, cultural and other factors - the need for them has been clearly established. Therefore, countries embarking on the use of space technology should organize and set up interagency co-ordination mechanisms appropriate to their situation and needs. In order to facilitate this and to provide examples of alternatives, the United Nations should collect, collate and disseminate information on the mechanisms devised by various countries who have had experience in space applications. Even prior to - or alongside - such efforts at co-ordination is the need to efficiently organize the resources (human as well as material) for planning and implementing space activities. Here again various alternatives do exist - ranging from allocation of specific space responsibilities to existing agencies to the creation of a new agency specially for space activities. Obviously, there is no unique solution applicable to all countries and all situations. However, the critical importance of a good organizational structure is now an established fact, and countries planning to use space technology need to pay special attention to the organizational frameworks, appropriate to the country and task, conducive to the co-ordination and speedy implementation of efforts.

215. Developing countries span a wide range in the spectrum of technological capabilities and infrastructure. Thus, while some may limit themselves to "end-use" (e.g., information utilization - see para. 209) or to operation of an earth station for international communications, others may be in a position to do more. For example, countries with trained personnel could perform for themselves the all-important job of systems studies: carrying out studies to determine the best means (space or non-space) to meet the country's needs in specific fields, in keeping with national priorities. This work should necessarily be done by a country itself, so as not to be influenced directly or indirectly by equipment suppliers or others, except in cases where such expertise is not available. In this situation, the United Nations and its specialized agencies should assist countries (see para. 212), but the involvement of local people even in such cases is a necessity.

216. More detailed systems planning, including conceptual designs and laying down of system specifications, is a further step that must be undertaken indigenously by countries that do have such expertise. This, and the subsequent step of preparing a document for inviting bids (often referred to as a request for proposals), are crucial steps that determine the extent of competition that will take place in bidding and therefore the costs. The ability to analyse the

resulting bids - in technical and managerial terms, in particular - generally requires a further level of expertise.

217. It should be noted, in this context, that not only the traditional space powers, the United States and the USSR, but also other countries make efforts, either nationally or through regional co-operation, to build up a capacity in the field of space science and technology. It is desirable that these efforts be pursued in order to make it possible not only for these countries to utilize space science and technology for their own needs, but also to offer an alternative as partners for developing countries in their efforts to use space science and technology.

218. In this context, it is important to note that some developing countries not only have such expertise, but have also had some experience in these processes. Other developing countries could greatly benefit by drawing on this experience as an independent source of expertise, since these countries are generally not involved in selling services or equipment for space applications.

219. A few developing countries now have both the human resources and the industrial infrastructure to fabricate ground hardware for space applications. This is a very important capability, because the ground segment for domestic space applications frequently needs to be tailored to the needs and the environment of the particular country. Equipment bought abroad might not only be too sophisticated and expensive but could also be less suitable than indigenous hardware and require local adaptation. Also, with indigenous fabrication comes better maintenance, development of know-how, employment and - above all - greater self-confidence. However, as a rule, such equipment has teething troubles in the early stages and is not as sophisticated as the latest equipment available in the world market. Because of this, most developing countries tend to ignore and even discourage indigenously-developed equipment. However, it must be realized that long-term benefits from modern technology, including space technology, can accrue only when a country develops to the maximum extent its own technological capability. Developing countries should strive to build their technological capabilities to the limit of their human and infrastructural resources. Also, developing countries must adopt a pragmatic, need-based approach with regard to equipment: unnecessary sophistication and forced obsolescence must be avoided, as should an addiction to owning the "latest" equipment.

220. Sometimes, the equipment needs of developing countries may be unique. An example of this is the direct reception equipment for receiving television prorammes beamed via satellite. The developed countries are focusing on development of individually-owned receivers, whereas the need of developing countries is for community reception equipment, operable on low-cost, local power-sources (preferably using renewable energy sources). In many such instances, developing countries would be well advised to first look for appropriate equipment from other developing countries. Alternatively, they may have to adapt off-the-shelf developed-country equipment.

221. Apart from the benefits mentioned, the indigenous fabrication of

equipment has been found to lead, in many cases, to advantageous industrial and management spin-offs. There is, therefore, a strong case for encouraging indigenous fabrication to the maximum extent possible.

222. A handful of developing countries now have active programmes to develop space hardware. Here again there are considerable direct and indirect benefits, but the magnitude of investment and the technological base required obviously limit the number of countries that can at present embark on such programmes. However, there is scope here for joint effort - a pooling of financial, human and industrial resources - by groups of developing countries, aimed at building a base that could lead eventually to space-hardware capability. Developing countries should explore the feasibility of such co-operative effort for both space-based and ground equipment and mechanisms for implementing them. The United Nations system should encourage and provide assistance to such efforts.

223. The utility and importance of "pilot projets" that provide countries with first-hand experience and the opportunity to evaluate a particular space application has been proven and recognized. Such demonstration projects seem to be a necessary step that helps to prove the utility of an application and to evolve appropriate mechanisms of co-ordination and implementation. It also enables the operational user-agency to gain confidence in handling the technology involved. However, demonstrations of space technology require a satellite, and therefore considerable financial resources. Much of this investment would be fruitless if the country decided not to go in for the particular application or to use a different system. Therefore, developing countries are encouraged to negotiate with launching States for the use of their spacecraft on a trial basis for experimentation or demonstration. Some developed countries have already provided such services, on a bilateral basis, with considerable success, and have thereby contributed substantially to the beneficial use of space technology by some developing countries. These promising examples should be multiplied, and more developing countries should be encouraged to determine - through first-hand experience - how best (or even whether) they should use space technology to meet their national needs and priorities. Such pilot projects are inevitably beneficial to all co-operating parties. Developed countries should continue to provide such services on equitable terms wherever feasible. Of course, in the case of meteorological and remote sensing applications, it may be sufficient - in the first instance - merely to provide access to the data. International financial agencies should provide financial support, as appropriate, for demonstration projects undertaken by developing counries.

224. In the fields of communication, meteorology and remote sensing, international organizations have played a vital role in making the benefits of space technology available to nations, particularly to the developing ones. WMO has, by its efforts, created a truly co-operative international network for meteorological purposes, benefiting all nations (see chap. III E). However, it has no space facilities of its own. Given the global nature of the environment and the crucial importance of weather forecasting to the economic well-being of nations (especially developing ones, with a very large proportion of their gross national product derived from weather-dependent agriculture), the crucial

e of meteorology is obvious. While a great deal of international co-operation exists in this field, fostered by Member States through WMO, there is need to build further on this foundation, especially in view of the growing importance and demonstrated potential of space technology in this field. Some countries, however, believe existing systems under WMO are excellent and that United Nations efforts might best be directed at this stage to provide training to enable developing countries to make use of available data. All countries should continue to have free access to meteorological data. To fulfil this objective, WMO should be encouraged to ensure optimal use of space techniques, in particular in the related aspects of facilities for data reception and processing, data analysis and dissemination. In the same spirit, WMO should also envisage to undertake a study concerning the possibility to set up an international structure providing access to satellite meteorological data.

225. Remote sensing by satellites is another application of great promise, and one of particular importance to the developing nations. Lack of trained manpower and high costs of processing and analysis facilities have been major obstacles preventing developing countries from deriving greater benefits from this technology. No agreement has yet been reached on principles that should govern satellite remote sensing. Work to this effect within the United Nations Committee on the Peaceful Uses of Outer Space should be continued as a matter of priority, aimed at speedy agreement on such principles. Assurances by satellite operators about continuity of data flows and lifetime of operational systems would be of great help to all countries, in particular developing countries. Compatibility of various systems and data formats is another important aspect; this is discussed in section F below.

226. Since remote sensing systems use orbiting satellites, they are in a position to collect data from many countries. One can, therefore, envisage the possibility of using shared or internationally owned remote sensing satellites. Some suggestions for such international systems have been made. Also,on the basis of resolutions adopted by the General Assembly, a detailed study on an international satellite monitoring agency has been carried out.

227. It is suggested that a study be undertaken to assess the need for and the viability of a world-wide remote sensing system, keeping in mind that only the space segment need be internationally owned. Such a study could consider various ways of providing remote sensing data - including regional, bilateral, multilateral and international arrangements - with the users bearing therefore the development, production, launching and operation costs of the satellites. Assuming that any one of these systems could provide assurance of continuity of data formats, avoid forced obsolescene of equipment, and enable the development and use of standardized data analysis software, the study should in particular indicate the comparative cost of such systems to the users vis-a-vis systems currently in operation and/or under development.

228. Satellite broadcasting is an application of special relevance to developing countries, since it can be used as a powerful tool for education. Benefits from a satellite broadcasting system for education and development can

e very substantial, but the organizing of such a system requires a great deal f a rt. This is discussed in greater detail in section E below.

29. Satellite communication is a field in which there has been a great deal f international co-operation for many years. However, intra-country ommunication - especially to and from rural areas - continues to be a major roblem in developing countries. Satellite communications can provide a quick nd efficient solution in many cases, and some developing countries do have lans for their own domestic systems. In this field, international arrangements ave been initiated by UNESCO to find optimum solutions.

30. Despite the low per-channel costs and the possibility of using inexensive earth stations, the capital costs associated with the setting up of a atellite comunications system are substantial. Since a large proportion of these costs is attributable to the satellite and its launch, a sharing of this etween different countries would make for lower investments by each. Techology has now made it possible to build and launch large satellites, each of hich could carry enough transponders to meet the telecommunications needs of a few smaller countries. When the capacity is saturated, another satellite could be launched. Thus, while the life of communications satellites is now 7 to 10 years, a country need not invest now for its requirement seven years later. Such a shared system has obvious advantages, and developing countries, in particular, could greatly benefit by joining together in the setting up of systems using a shared or common satellite(s). The Arab Satellite Communications Organization (ARABSAT) is an example of such a system and it is desirable that other groups of developing countries study the feasibility of such regional systems. INTELSAT is not optimally designed for domestic communications, but an increasing number of countries, including many in the developing world, are using it for this purpose. Although INTELSAT may increasingly be used to serve the domestic communications needs of more countries, the feasibility and desirability of specially designed systems for rural telecommunications (e.g., the ITU GLODOM proposal) should be examined.

231. [While communications, broadcasting, remote sensing and meteorology are the major applications of space technology, there are others that can be as important in certain situations. Satellite geodesy, for example, has important applications - in cartography, seismology, etc. The related field of satellite navigation is also of growing importance to developing countries, especially those with maritime interests. Unfortunately, increasing military use of this may result in restricted availability of existing systems for shipping and air traffic use by developing countries. Since geodetic and navigation satellites have to be in low earth orbit, in this case also - as for remote sensing - it may be appropriate to consider an internationally-owned space segment to which all countries could have access. As a first step, the United Nations, in co-operation with concerned specialized agencies, should initiate a study on the feasibility of such a system and work out technical, financial and organizational details. The technical feasibility and benefits of combining the remote sensing (see para. 227) and navigation missions should also be examined.]

232. As noted earlier, INTELSAT provides one example of an internationally-

owned space segment; similarly, INTERSPUTNIK has operated through leased spacecraft. More recently, the setting up of INMARSAT demonstrates once again the feasibility, need and benefits of international co-operation in space. It also provides a paradigm of a mechanism for channelling such co-operation into an operational and beneficial system.

233. Clearly, international co-operation is essential if all countries - and especially the developing ones - are to derive benefits from space technology. While developing countries will need assistance from developed countries and from international organizations, they can achieve a great deal on their own and by co-operating with each other also. In all this, the role of the United Nations will be of crucial importance. Some aspects of these issues are discussed in chap. III.

### D. Facilitating access, use and development of space technology

234. It is sometimes assumed that any involvement in space technology or applications requires a substantial infrastructure of very sophisticated industry and very large research laboratories, and is therefore outside the reach of developing countries. In fact, it is not so and quite a few developing countries are actively involved in a variety of space applications and also in the development of space technology. Some infrastructure is certainly required - even for only using space technology - but this is not more substantial than what exists now in many developing countries.

235. The basic requirement is, of course, human resources. What is needed is [illegible] "space technologists", but experts in various disciplines that contribute to space technology - electronics, computer science, engineering, and application specialists (meteorology, agriculture, geodesy, etc.) as well as the necessary support personnel. A country can begin to apply space technology with just some simple equipment - costing a few thousand United States dollars - data products from a remote sensing or meteorological satellite, and a few applications experts who convert the data into useful information. This data analysis itself can, of course, be taken to increasingly sophisticated (and expensive) levels, requiring large, sophisticated computers and other equipment that could cost millions of dollars. How far a country wants to go would depend upon its needs, priorities and extent of matching infrastructure to utilize the information.

236. Infrastructure and the extent of use of space technology are, thus, interdependent. Simple uses of space technology (as in data analysis) needs only minimal infrastructure - mainly for equipment maintenance and operations - while more complex uses need a bigger and more sophisticated infrastructure. At the "basic" level, the greatest need is for equipment operation and maintenance, which need mainly adequately trained technicians. Beyond this, one needs human and engineering capabilities for equipment modification, fabrication and development. These activities, in the case of equipment for terrestrial use, obviously require less infrastructure than in the case of space-worthy equipment.

237. Development of human resources is probably the single most important - and time-consuming - element of infrastructure augmentation. Though some developing countries do have a fairly good base of qualified manpower, most are deficient in this important aspect. While each country will have to decide for itself the best approach to this problem, it can be generally recommended that countries examine and modify as necessary their education system and curricula to place greater emphasis on science and technology. Also, at post-graduate level, interdisciplinary work on areas connected with space technology and its applications must be encouraged.

238. These measures can have an impact only in the medium or long-term. In the short-term, it is recommended that the United Nations organize a fellowship programme through which selected graduates or post-graduates from developing countries can get in-depth, long-term (one to two years) exposure to space technology or applications. These fellowships - numbering at least 100 each year - may be at universities or training institutions, but should preferably include a substantial amount of on-the-job experience. As far as possible, the selected institutions/training centres should also be in developing nations.

239. Simultaneously, the United Nations should support the development of appropriate training centres at regional levels, linked, whenever possible, to institutions implementing space programmes. These could be located in developing countries that have active space programmes. Necessary funding for the development of such centres should be made available through international financial institutions. These training centres should organize - with United Nations assistance if necessary - regular training courses of varying durations for different levels of trainees from developing countries. In the long term, technicians' training should be done nationally and these regional centres should become centres of excellence, partly for high-level "training", but primarily for exchange of knowledge through seminars, etc. The faculty should be international and drawn from developing countries to the extent possible.

240. As a third step, the United Nations should itself conduct - as part of its space applications programme and in association, where appropriate, with the concerned specialized agency - regular three to five-week seminars for high-level personnel concerned with space applications and space technology. These seminars should focus on the organization of technological or applications efforts and be broadly "managerial" in content. The primary purpose would be the enhancement of knowledge and skills of key leaders through exchanges of experience with others, discussions on problem areas and seminars on new and potential applications. These seminars would be in addition to the specialized training courses that are conducted (and should be expanded as necessary) by various specialized United Nations agencies.

241. Unfortunately, past experience indicates a considerable "wastage" from training efforts because in some cases there is no organized institutional framework for the trainees to return to in their home countries. Thus, persons trained in remote sensing might end up doing something altogether different. While one could impute advantages to such widespread seeding as a means of spreading awareness of space technology in the most unlikely places, the

short term effect is to nullify the utility of training. Countries should therefore plan some organizational infrastructure even as they send out people for training. In this context the training of managerial or leadership personnel through the seminars mentioned earlier assumes special importance. A minimal amount of physical infrastructure (equipment, etc.) is also necessary, so that the returning trainees can practice and sharpen their shills, even if no application is immediately taken up. Countries also need to take note of the need for a "critical mass" before good work can take place. It is,therefore, advisable to train several people at least from each country in a given discipline.

242. It is clearly desirable that there should be wide access to knowledge and that steps should be taken to facilitate such access. While scientific meetings and seminars - including, in particular, those organized by the International Astronautical Federation (IAF) and the Committee on Space Research (COSPAR)and other bodies of the International Council of Scientific Unions (ICSU) - play an important role in facilitating the free exchange of scientific data and findings, there is also a need to consider arrangements for transfer of technologies. In this context, the recommendations of the United Nations Conference on Science and Technology for Development (see A/CONF.81/16) on this subject are of importance and should be implemented. In keeping with this, countries should not place undue restrictions on the sale of components, subsystems or systems required for space applications.

243 While it is possible to undertake space applications on the basis of imported equipment, it is necessary that countries develop at least a minimal capacity for development of space tecnology. This "minimal capacity" will depend upon the extent of involvement - and proposed involvement - of the country in space. Such a base is necessary to ensure independent decision-making, to absorb and adapt technology and to promote endogenous development. It is therefore essential that developing countries organize and encourage indigenous development of capabilities, even while they may resort to import of equipment or technology in order to "buy time". Developed countries, the United Nations and international financing agencies should consider providing all possible help to developing countries in the setting up of such indigenous centres for absorption, adaptation and development of space technologies. The basic nuclei for such centres already exist in most countries, either in a university or in an existing research laboratory or institution.

244. It is a fact that in many developing countries' indigenous expertise and capabilities are not given due recognition and encouragement. Developing countries should take steps to encourage and develop fully their already existing technological capabilities and take planned meaures to decrease their dependence on foreign expertise. While imports of components and equipment may be necessary - even desirable, from an economic angle - countries must strive to develop thier own system-design and system engineering capability. In this context, developed countries should not always provide equipment in complete-system or "package" form, but should be willing to provide individual elements. Developing countries should strive to import such separate elements instead of integrated systems so that system-design, engineering and integration can be

done by each developing country according to its needs, requirements, capacity and environment.

245. In the long run, countries should consider if and how their industrial development should cover space technology. Equipment for almost any space application requires a great deal of simple mechanical/structural fabrication work which needs only a fairly rudimentary industrial infrastructure. Of course the fabrication is often to high accuracies, but even so, most of this work can be done without large investments. Developing countries could therefore begin indigenous production of space technology elements with mechanical items - e.g., fixed pointing antennas. Comparatively simple mechanical elements often account for a substantial proportion of system costs and therefore such indigenous fabrication will also result in lower outlays of scarce foreign exchange. It will also upgrade skill, quality control and reliability in the particular sector with general benefits for non-space activities also.

246. Design and production of professional electronics items - even from imported components - often need fresh investments (especially in test instruments) and new skills. However, the electronics industry in general is characterized by a high employment-to-investment ratio: a factor of vital importance to developing countries. Therefore, countries which have the capability and the nucleus of an electronics industry could consider expanding this for space needs if they are planning to get into appications like satellite broadcasting, which call for a large amount of electronics.

### E. Use of space technology for education

247. One of the important requirements for sustained growth and creating autonomous technological capabilities in developing countries is to improve the educational infrastructure. The needs go beyond educating the young, to providing a continuing source of information, knowledge and know-how to the adult population, some of which might be illiterate. Conventional methods of addressing these problems sometimes do not meet the appropriate needs of the rural population in this regard. While the use of space technology cannot provide instant solutions to these problems, it can complement conventional methods and accelerate the spread of education and improve its quality, particularly in remote rural areas.

248. Radio and television have been used as educational tools for many years. Radio has the advantages of wide reach, low cost and can be used even in unelectrified locations; despite this, and notwithstanding the fairly extensive radio coverage even in developing countries, radio has not yet been fully exploited for educational purposes. However, it does have the constraint of being only an aural medium. Television, on the other hand, can be an extremely powerful instrument for spreading education. Until recently, its use was constrained by the fact that reception of the broadcasts was possible only within about 100 kilometres of a transmitter. Thus, to broadcast television programmes to a given area, one had to set up a television station nearby, or set up a television transmitter and link it to a television studio or station. Now, however, space technology has made possible the reception of television pro-

grammes, even in very remote areas, without the need for a television station nearby or ground links. The technology of direct broadcast satellites (DBS) has been demonstrated by Canada, Japan and the United States, and a large-scale educational television experiment using the ATS-6 satellite of the United States was carried out in India in 1975/76. Some other countries also have carried out experiments involving the reception of satellite-relayed television programmes by specially augmented television receivers. Canada now has an experimental DBS system, and many countries or groups of countries are planning operational DBS systems.

249. A DBS system basically uses the principle of "complexity inversion", so that simple and inexpensive receiving equipment on the ground is made possible by a powerful and complex satillite. Obviously, such a satellite is expensive, and, therefore, the economics of a DBS system are dependent to a large degree on the number of receiving stations on the ground. There are, of course, a large number of other variables - including, in particular, the frequency band used and the EIRP of a satellite - and the cost of the receiving equipment is largely determined by these. However, it seems clear that a DBS system becomes worthwhile only if it serves a fairly large number of receivers. Many systems for direct-to-home television broadcasting are being proposed and planned. Selection of an appropriate reception mode, either individual or community, will be determined by the specific characteristics of each country. For the developing countries, emphasis may be put more on the community mode of reception. At the same time, it would seem economically attractive and beneficial for small countries to share a satellite, especially on a regional basis. Another possibility is an internationally-owned satellite that provides direct broadcast service to countries. In both cases, there could be transponders dedicated to each particular country, or countries could share a transponder, depending upon their usage. Differing time-zones could also enable a sharing of transponders, if the use was limited to a few hours only and the countries were widely separated along the east-west direction. Such a sharing of a satellite - which could be as large as necessary, within technological limits - would also contribute to reducing the pressure on the geostationary orbit (GSO). It is therefore suggested that:

(a) Countries might examine the feasibility of using DBS to aid the spread of education;

(b) Countries could explore the possibility of sharing the space segment of a DBS system, including the possibility of using any existing/planned satellites that might be suitable;

(c) Studies should be undertaken to examine the feasibility of international or regional satellite systems(s) for providing direct-broadcast television service;

(d) The United Nations and concerned specialized agencies should encourage and provide assistance - as appropirate and if requested - for the above;

(e) Existing organizations such as INTELSAT may choose to consider developing broadcasting satellite systems which could be used for educational purposes.

250. It should be noted that many countries which are now planning direct broadcast satellites intend to combine this service with telecommunications, with obvious economic advantages. Other countries - or an international satellite system - could examine the cost-effectiveness of such multimission platforms so as to increase the attractiveness of the system.

251. Community reception will probably be - as noted earlier - the primary mode of receiving satellite television broadcasts in developing countries. Tens of thousands of receivers will be needed in each country and it is essential to reduce the cost of each installation as much as possible. Also, given the lack of rural electrification in most developing countries, it is necessary to think of power sources that are inexpensive, and preferably use renewable forms of energy rather than hydrocarbons. It is therefore desirable that strong encouragement - including financial and technical assistance, if necessary - be given to efforts aimed at developing low-cost community receivers for DBS and low-cost, preferably renewable, power sources to operate the system in unelectrified locations.

252. Since the cost of the reception system for a given coverage area depends on the frequency and EIRP of the satellite, it is suggested that efforts at developing more powerful broadcasting satellites, within the constraints of international regulations, be pursued and encouraged.

253. [The question of frequency is a complex one, and the choice of an appropriate band involves many considerations and constraints. The ITU World Administrative Radio Conference (WARC) in 1977 agreed on an orbit/frequency assignment plan for countries in Africa, Asia and Europe for the 12 GHz Broadcast Satellite Service (BSS) band. Because of existing services, space service allocations in the lower portion of the frequency spectrum are constrained by flux density limitations so as to cause no harmful interference. The absence of such constraints could have led to simpler and cheaper ground reception equipment. The importance of these bands (especially the 0.7, 2.5 and 4 GHz bands) is not merely due to the lesser technological complexities compared to higher bands, but also to the fact that they do not suffer the severe rain-attentuation that higher frequencies (e.g., 12 GHz) do - a point of particular importance to countries with high rainfall rates. It is therefore desirable that ITU study the feasibility of phasing out - in the long run - the terrestrial services in some of these bands, so that they can be assigned exclusively to satellite broadcasting and the flux density limits relaxed. In view of the existing investments and extensive spread of terrestrial networks that share these bands, any such changes would be difficult and do not seem feasible in the immediate future. Also, allowing higher radiated power from spacecraft and smaller terminals on the ground could result in decreasing the "capacity" of the GSO due to need for greater separation between satellites so as to avoid interference. However, should ITU recommend, and one of the World Administrative Radio Conferences adopt such steps, they would result in greatly

reduced costs for DBS systems and provide a major stimulus to education via satellite.]

254. While considerations with regard to the hardware elements of a DBS are of obvious importance, the other "software" elements unfortunately tend to be neglected. Experience has, however, indicated that these aspects are crucial to the success of a DBS system for education. The main ones include:

(a) System planning and integration;

(b) Organizational aspects including system management and co-ordination;

(c) Design and production of appropriate television programmes, relevant to the needs of the audience and in keeping with national priorities;

(d) Feedback and evaluation mechanisms, especially with regard to audience reactions and impact;

(e) Organization of viewing arrangements and of post-programme follow-up ("utilization"), including ensuring of actual availability of recommended items, training of teachers for optimal use of the system, etc.;

(f) An efficient field maintenance system.

255. The importance of these aspects cannot be over-emphasized, especialy because they have all to be taken care of indigenously: unlike the satellite or even receiving equipment, they cannot be imported nor do they exist in ready-made form. Even when similar elements do exist elsewhere (e.g., educational television programmes), they should be used - if at all- only with great caution, since their relevance, their ability to create audience-identification and their cultural effects may pose problems. Countries which plan to set up a DBS system would therefore be well-advised to devote effort and attention to these "software" aspects.

256. The community receivers that form part of a DBS system need not be used merely for one purpose - e.g., educating school children - but could fulfill many needs in diverse fields. A case in point is the Satellite Instructional Television Experiment (SITE) in India, during which the system was used for school education in the morning and for health, family planning, nutrition, agriculture, etc. in the evening. During school vacations, teacher-training and special programmes for agricultural extension workers were broadcast. Canada too has made use of a DBS for tele-health and tele-education. Thus, one could use the same system for specialized education (for teachers or agriculture/health extension workers), school education and general education of the total audience (e.g., in fields like health or nutrition). Such multi-purpose use obviously increases the benefits; however, it does call for closer and greater co-ordination between various agencies - e.g., the Ministries of Health, Education and Agriculture.

257. While television is a powerful tool, it does provide only one-way communication.To overcome this limitation, experiments have been carried out using a return audio channel from the audience to the source - either via land-lines or by again using a satellite. In some experiments, a return video link has also been tried out. However, the additional cost of return audio links is high - because, in most developing countries, land-lines do not exist in remote areas - while return video links are prohibitively expensive. It does not, therefore, seem worthwhile now to provide such return links, except for very special purposes when the very substantial additional cost is justified by the resulting benefits or by the particular situation. In any case, the fact that such return links can only be originated from a few places at a time acts as another constraint. Thus, while immediate "on-line" feedback is a desirable part of the educational process, in a DBS system this is not easy, and the teacher or animator must provide the interventions and clarifications that are required.

258. The telecommunications systems in almost all countries have seen tremendous expansion in the last few years. The introduction of satellites in the communication system will lead to an even more dramatic growth. Of late, more and more countries are considering how this large system can be used for educational purposes. While the availability of telecomunications in rural areas is as yet very meagre, it is now possible to think of extending coverage even to remote areas by the combination of a satellite and UHF/VHF transceivers. Through the use of appropriate terminal equipment, it is possible to receive and transmit voice, data, facsimile and slow-scan pictures. The educational possibilities that such a system - with two-way communication capabilities - could open up are substantial. It is therefore suggested that the United Nations, in co-operation with the appropriate specialized agencies (including, especially, UNESCO which has done much work in this field), initiate a study on the educational opportunities that emerge from satellite and related telecommunications technologies.

259. Advances in technology have given rise to a number of new products and equipment in communications. In order to meet the particular needs of a country, it is necessary to put together these various elements in a system appropriate to those needs. This system engineering, the configuration of the various elements into an integrated whole, determines to a large degree the success and benefits that will result. It is essential that this be done by persons completely familiar with the needs, capabilities and resources of the country for which it is meant; however, in the absence of indigenous expertise, the United Nations system should, upon request, provide or arrange to provide assistance to countries to develop appropriate system configurations for using space technology for education.

### F. Compatibility and complementarity of satellite systems

260. Compatibility between different satellite systems enables users of one system to use other systems at relatively little additional cost; to the extent that this provides additional useful data or redundancy, it increases the benefits for the user. Since a vast majority of countries use space technology to some degree, the benefits of compatibility could be truly global.

## 1. Meteorology

261. A striking example of the advantages of compatibility is provided by the world-wide meteorological satellite system. All the satellites have been designed and built primarily to meet the needs of specific countries or regions; accordingly, the characteristics and sensor package vary from system to system - sometimes even from satellite to satellite within a single system. However, in the vital area of data dissemination - where compatibility is both more feasible and desirable - the transmission frequencies have been standardized, so that the ground equipment of users can receive data from different systems. Member States, working through WMO and ITU, have brought about this very happy and mutually beneficial situation by continuing the traditionally close co-operation existing between States in the field of meteorology. As a result, the World Weather Watch (WWW) is now supported by the orbiting and geostationary meteorological satellites of various countries and of the European Space Agency (ESA).

262. Completely compatible data dissemination has made it possible for countries to receive APT imagery from the polar orbiting United States TIROS-N/NOAA and USSR METEOR satellites. The same format is also used for relaying processed imagery from geostationary satellites, as part of the Weather Facsimile Service (WEFAX). While technological advances and innovations are obviously to be encouraged, the need and importance of continuing compatibility must not be lost sight of.

263. Complementarity of systems for meteorology involves complementarity of: (a) spatial coverage, (b) data and (c) temporal coverage. As far as observations from GSO are concerned, there will soon be complete world-wide spatial and temporal coverage up to about 60 to 70 degrees latitude. In the case of polar-orbiting satellites - which typically provide global coverage once a day - the frequency of coverage can be increased by the use of complementary orbits. Complementarity of data depends on sensor design, and close co-operation between system designers and also between designers and meteorologists should be encouraged.

264. WMO has played a very positive role in encouraging and bringing about close co-operation in the field of satellite meteorology. Specifically, WWW has proved to be an effective mechanism for promoting compatibility and complementarity between different meteorological satellites. The co-ordination on geostationary meteorological satellites is an example of successful and voluntary co-operation among current operators of meteorological satellites, and operators should be encouraged in these efforts. WMO should continue to actively promote international co-operation in this field, encourage compatibility and complementarity between different systems and take all necessary steps to ensure continuity in data availability to all countries. This aspect should be considered in the study proposed in para. 224.

## 2. Remote sensing

265. Unlike meteorology, remote sensing is not yet at the operational stage.

Though much work has been done, the systems are yet at what may be called a "pre-operational" stage. However, it is only a matter of time - and a short time - before this very important application attains a completely operational status in some countries at least. It is therefore opportune now to look at ways in which compatibility and complementarity could increase or spread wider the benefits from this important space application.

266. Compatibility between different systems would enable use of the same equipment for reception of data from more than one system and thus minimize both capital and operating costs. Further, compatibility of formats could permit the use of the same equipment for processing data received from different systems, and also possibly, use of the same software for analysis. Thus, compatibility would greatly benefit users of remote sensing data.

267. Some co-ordination is already taking place among some of the satellite operators in this field. For instance, the United States and France have ensured compatibility of satellite-to-ground transmissions (using the 8 GHz band) of image data from the LANDSAT-D and SPOT satellites. This will enable reception of data from both systems with the use of a single station. Further discussions with other countries planning satellites are taking place to make future systems compatible with each other. ITU is also playing a role by allocating a band (8 GHz band) for transmissions by remote sensing satellites, so that the same antenna, feed and RF receiver could be used on the ground for reception of data from any remote sensing satellite.

268. However, aspects other than transmission frequency are also important, in terms of compatibility. These include format, annotation and data product standardization. To discuss these and issues like co-ordination of data acquisition, processing and distribution, the United States initiated some years ago meetings of a LANDSAT Ground Station Operators Working Group. Similar groups are likely to be set up by other remote sensing system operators: France, for example, has already announced that it will form a similar group of operators of SPOT ground stations. These are positive developments and co-ordination between these different groups should also be encouraged.

269. Data products are produced in various formats and classes, including quick-look photographic images; standard photographic images; standard computer compatible tapes (CCTs); precision and geometrically corrected CCTs and high-density digital tapes (HDDTs). Standards with regard to these could be useful but may require changes in equipment. Also, user needs vary so much that this may not be desirable. However, standard annotation on photographic images, and on standard family of formats for CCTs (as suggested by the LANDSAT ground station operators) could be useful. The latter is adaptable to non-image data as well and can be used for interchange of data. With regard to precision-corrected CCTs, there is need for some standardization about pixel sizes, data orientation and map projection, even though needs of users do vary a great deal. The present differences cause difficulties to users obtaining data from different ground facilities.

270. To overcome some of these problems, and particularly to facilitate the

utilization of data from multiple complementary missions, efforts should be devoted to the development of CCT and film products which are platform and sensor independent in a cartographic projection. These products, with subpixel geometric accuracy in multitemporal registration and in absolute geodetic control, might be offered in subscene format to meet a range of user coverage needs and in projections compatible with various geographical data bases. Ground station operators should be encouraged to undertake this effort.

271. Remote sensing missions depend upon a variety of factors, including user need, sensor technology, launch capability, ground system technology, etc. The combination of all these factors severely limits flexibility for achieving co-ordination and complementarity. While co-ordination of systems is a desirable goal, its practical feasibility is limited.

272. Given the investments already made on the ground by many countries - in the form of ground stations, processing equipment, data archival, software, etc. - the important element is continuity of data availability in a form compatible with present systems. System operators might keep this consideration in mind in the planning of future systems.

### 3. Communication

273. The need for compatibility in the field of satellite communication was obviously essential for international communication. Further, co-ordination between different systems is necessary in order to avoid harmful interference. These needs have been well recognized by the international community and, through ITU, there now exists an established system of co-ordination in this field. The problems with regard to GSO and the RF spectrum are being discussed in the ITU forums, and are dealt with separately in section G below.

### 4. Navigation and other services

274. The need to ensure compatibility and to co-ordinate certain other services like search-and-rescue, distress signalling, etc. are obvious and the situation regarding co-operation in these fields is encouraging. However, with regard to navigation applications, the picture is not so positive. This is an area of growing importance, and consideration should be given to the feasibility of establishing an international system with the active participation of all States (see para. 231).

### 5. Over-all considerations

275. While compatibility and complementarity between different systems would generally be beneficial, and therefore desirable, certain considerations need to be borne in mind. Briefly, these may be summarized as follows:(a)It should not inhibit new ideas, innovations or advances in technology;(b)It must not act as a hindrance to technological self-reliance;

(c) Systems must be need-based and user-oriented; technical and legal strait-jacketing must therefore be avoided;

(d) It should not result in higher costs or excessive dependence on one State by many others;

(e) For non-global systems, independence of individual systems may sometimes be advantageous.

276. Though some of the above may seem to restrain compatibility and complementarity, these considerations need to be borne in mind in evolving a pragmatic approach towards co-operation in space, and one in which all countries have genuine opportunities to reap benefits.

### G. The geostationary satellite orbit

277. GSO is a unique natural resource of vital importance to a variety of space applications, including communications, meteorology, broadcasting, data relay from and tracking of orbital satellites, etc. It could also be used for such possible future applications as solar power satellites. Though not depletable, GSO is a limited natural resource. Therefore, as with any limited resource, its optimal utilization requires planning and/or arrangements.

278. Utilization of GSO cannot be considered in isolation: the associated issue of use of the radio frequency (RF) spectrum must be simultaneously looked a The RF spectrum is also - like GSO - a limited (in practice) though non-depleting resource. While in theory it does extend indefinitely, practical constraints limit its present use to a comparatively small band. Hence, its optimal use also requires planning and/or arrangements.

279. It is in the light of this that the members of ITU have been making concerted efforts to evolve systems for planning and regulating the use of the GSO and the RF spectrum since 1963. It is noted that the forthcoming ITU Conferences in 1985 and 1987, which will continue this process in the light of technical progress and in the light of the broad considerations outlined here, will decide, in accordance with resolution 3 of WARC 1979, which space services and frequency bands should be planned.

280. Recent years have seen the explosive growth in the use of GSO, especially for communication satellites. To the extent that this signifies increasing use of space technology for beneficial purposes, it is to be welcomed. However, while GSO is occupied largely by developed countries' satellites and international systems (ref. section III A), there are countries which have not yet placed satellites in GSO; and increasing concerns have been expressed that these positions may not be available when they desire to use them, and that assignments in certain frequency bands (e.g., 4 or 6 GHz) may become more difficult to obtain in future due to congestion . While there now seems to be general awareness of this concern, and certain regulations have been adopted, the present system of registration and co-ordination may need to be improved to guarantee, in practice, for all countries, equitable access to the geosta-

tionary satellite orbit and the frequency bands allocated to space services. I this regard, it may be noted that WARC 1979 resolution 2 states that "the registration with the IFRB of frequency assignments for space radio-communication services and their use should not provide any permanent priority for any individual country or groups of countries and should not create an obstacle t the establishment of space systems by other countries."

281. Despite lack of agreement on defining the precise boundary between air space and outer space, it is accepted by most nations that GSO is a part of outer space and, as such, it is available for use by all States, in accordance with the Outer Space Treaty of 1967. However, the equatorial countries consider that the GSO constitutes a physical phenomenon related to the reality of our planet in that its existence depends exclusively on its relation to gravitational phenomena generated by the earth, and that for this reason it should not be included in the concept of outer space and its utilization should be regulated under a *sui generis* regime. The International Telecommunication Convention states that GSO and RF spectrum must be used efficiently and economically so that countries or groups of countries may have equitable access to both in conformity with the provisions of the Radio Regulations according t their needs and the technical facilities at their disposal. Given the limited nature of the resource, efficiency of use is certainly important and any plan and/or other arrangement that is formulated must encourage greater efficiency. However, efficiency of GSO and RF spectrum usage should not be a barrier to attempts at technological self-reliance. A leading role in the promotion of [illegible] efficient use will no doubt be taken by countries with advanced space technology; and the positive efforts of the developed countries to increase efficiency should be supported and continued. [Further, the newer technologies that lead to better utilization (e.g., better station-keeping, higher frequencies, shaped antenna beams, etc.) should be adopted in so far as possible by all countries and international organizations.] The improvements in the utilization of GSO that would arise from the use of new technologies should permit all countries to have access to space technology at a level of sophistication appropriate to their needs and requirements. It should be noted that there is already a positive trend toward the utilization of new technology, and this should be continued.

282. Efficiency of use cannot be an end in itself: it is only a means of ensuring all countries equitable access to this scarce resource. In particular, there are many developing countries which do not now have either the resources or the need to use GSO but are likely to do so in the future. Any planning method and/or arrangement that is evolved should recognize and accommodate the future needs of developing countries and should not result in unnecessarily hastening their plans to the detriment of their financial and self-reliance interests.

283. GSO is getting increasingly crowded with objects that have outlived their utility. While the danger of collision or physical damage by these objects to active satellites is yet small, this is a problem that is likely to become more serious in future. Therefore, ITU should examine the feasibility of incorpor-

at[illegible] in its future regulations a stipulation that a satellite owner is responsible for removing its satellites from GSO when they are no longer in use.

284. In noting the phenomenal growth in the use of GSO - especially for communication satellites - and the consequent usage of RF spectrum, it may become necessary for each country or international organization to examine whether all the satellites it is operating are really required. Increasing numbers of satellites are being used for various purposes by different countries. To the extent that these systems use national resources, it is the concern of the country involved. However, these systems use increasing amounts of a limited resource that is for use by all States. It is therefore desirable that Member States, within the ITU, continue to evolve some criteria for the most equitable and efficient usage of GSO and the RF spectrum and to develop planning methods and/or arrangements that are based on the genuine needs, both present and future, identified by each country. [Clearly, such a planning method should emphasize those uses which promote development, including education. It should also ensure equity, consider the needs of developing, tropical and far-northern countries, and take into account the special interest of the equatorial countries.]

285. For certain purposes and locations, it may not be essential to use GSO. Since increasing concerns have been expressed regarding the congestion of GSO, countries should also examine whether for their needs they could use a satellite in elliptical orbit rather than in GSO. Similarly, the feasibility and overall advantages of using elliptical orbits for international communication merit re-examination.

286. Lower launch costs and advances in other areas of space technology have now made it possible to conceive of a very large variety of possible systems including large space platforms in GSO. A single such platform could be designed to meet simultaneously the needs of a number of countries. However, it is not yet clear that such a concept will offer the flexibility required by the varying and special needs of these countries, lead to lower cost for each of them and help improve use of GSO and the RF spectrum. In order to demonstrate the possibility of this concept, it would be useful for those countries that are interested to evolve a broad design for such large platforms. In this context, it should be mentioned that improvements in the use of GSO could also be achieved by using both ground and satellite-based narrow-beam antennas. The planning method and/or arrangements developed by ITU should be flexible enough to permit the introduction of new types of systems taking into account the needs and requirements of all countries.

287.It needs to be noted that the development efforts undertaken by the technologically advanced nations have resulted in new techniques that contribute to more efficient use of GSO and of the RF spectrum. These efforts must be encouraged and continued, for success in this could effectively increase the capacity of GSO and thereby alleviate possible pressures on its use. New developments in the field of fibre-optic technology are also likely to contribute positively, by directing high-capacity traffic on transcontinental and transoceanic routes to optical fibre systems.

288. In conclusion, considering the long term implications of the growing activities in GSO, any solution on the use of GSO should be both equitable and flexible and take into consideration the economic, technical and legal aspects.

## H. The nature and protection of the near-earth environment

289. The rapid advances in space technology have led to a considerable increase in the extent and type of applications, as well as to greater use of space for scientific research in a variety of fields. The resulting increase in the number of both space objects and launches is, however, not an unmixed blessing. One facet of this problem is the vast number of space objects - estimated to be in the thousands - now orbiting the earth. A majority of these are now "space debris": dead satellites, spent rocket motors, nuts and bolts, etc. While the probability of accidental collision with a "live" space object is yet statistically small, it does exist and the continuation of present practices ensures that this probability will increase to unacceptable levels. To minimize such an eventuality, the international community might, on the basis of more detailed studies, agree to appropriate measures, such as designating certain orbits as "disposal orbits," removing from orbit all inactive satellites, minimising space debris or even organising scavenging missions.

290. A more serious facet of the problem concerning the near-earth environment is the possible danger associated with environmental modifications caused by space activity. Pollution and reactions resulting from rocket launches are a cause for increasing concern: even though the number of launches per year has remained more or less the same from 1965, bigger and bigger rockets are being used. Also, many of the effects could be cumulative. Although no major and continuing ill-effects have yet been detected, substantial and sometimes serious regional disturbances - affecting radio propagation, for example - have been documented, especialy when large thrusters were ignited at higher altitudes. Effects on radio communication have also been observed due to re-entry of large objects. Such problems could assume serious proportions if very large launch vehicles - of the type proposed for the construction of a solar power satellite (SPS), for example - were to be used on a frequent basis.

291. The disturbances in the ionosphere due to the release of gases by rockets or due to collection of charged particles by large - particularly metallic - satellites/structures is a problem that is under study, but which is not completely understood yet. The depletion of the ozone layer due to space activities, though not serious yet, could also become a problem with many implications.

292. Certain scientific experiments involve the release of chemically reactive substances - for example, metal vapours - into space. These are undoubtedly important tools for research, but such activities could also result in unintentional changes causing a deterioration in the natural environment. They could affect the electron density, cause plasma depletion and create a "hole" in the ionosphere. Some experiments to intentionally create such holes are planned, and will probably produce scientific insights that cannot be obtained in laboratory experiments. However, the excessive release of materials in

space can be risky, and caution is called for, even though environmental impact studies have, to date, indicated no serious long-term consequences.

293. Use of ion engines for propulsion seems to be a promising development, and some scenarios of large-scale construction in space call for the use of powerful ion engines for transfers from low altitude to GSO. However, the deposition of argon in the magnetosphere due to powerful ion engines could produce strong and long-lasting distortions in the outer environment of the earth. While a number of environmental impact studies have been performed to assess this problem, the time delay for natural recovery is yet an open issue, as are other uncertainties.

294. While the benefits of large number of launches and of various scientific experiments may not be available to all countries equally, many of the potential risks of these activities can be truly global. For the guidance of all States, the United Nations - in particular, UNEP - should encourage the continuation and expansion of on-going studies by groups of independent experts to:

(a) Study the deleterious effects of intentionally releasing gaseous or other material in space for scientific studies and recommend limits on such releases;

(b) Collate existing findings and - if necessary - undertake further studies to determine the effect of rocket launches, particulaly of frequent and large-rocket launches, with the aim of recommending desirable limits on size, frequency or fuels from the point of view of minimizing ill-effects on the global environment;

(c) Evaluate the effects of using ion engines for propulsion and suggest means of minimizing the distortions caused in the outer environment of the earth due to their use.

295. Electromagnetic waves in space are also an issue that could cause concern. Some controlled experiments in producing electromagenetic waves in space have been carried out and no serious consequenes have been detected. There is also the large radiation of energy into space from radio transmitters used on earth for a variety of uses, including powerful radars, and from power distribution lines. While the effects of these have been detected, their magnitude is yet debated and it seems likely that larger effects may be produced in future. In particular, radio transmitters on board satellites - essentially in HF and VHF bands - can generate electric and magnetic fields at large distances from the satellite, and their sidelobes can cause disturbances to other satellites. ITU is considering this problem with regard to the present range of applications. However, if and when SPS are in service, this problem will become rather serious, due to the enormous energy flux involved.

296. For certain space applications, the use of nuclear power sources (NPS) presents advantages. However, the use of NPS may entail risks that concern all States. The issue of the use of NPS is at present under discussion in the two sub-committees of COPUOS in the context of examining the use of nuclear power

sources in outer space and the possibility of supplementing the norms of international law relative to the use of such power sources in outer space.

297. The biological risks to mankind from space activities have been examined. These include the risks of:

(a) Terrestrial micro-organisms contaminating other planets;

(b) Extra-terrestrial micro-organisms contaminating the earth;

(c) Space environment causing dangerous mutations of terrestrial micro-organisms.

298. Present studies indicate that there is little danger of any of these possibilities and, therefore, this is not a cause for concern. However, continuing studies should keep these risks in mind.

299. Astronomy - especially infra-red and radio astronomy - is in danger of being affected by space activities. SPS and exhaust gases from rockets could be a hindrance to infra-red astronomy, while the increasing electromagnetic radiations from satellites can cause interference with radio astronomy. The International Radio Consultative Committee (CCIR) of ITU is looking into the latter question and working towards ensuring co-operation between radio astronomers and satellite designers. Large numbers of small satellites, or large space structures like SPS, could also cause interference to radio astronomy due to spurious emissions and also as passive reflectors. However, it should be noted that space activities have contributed very positively and substantially to the growth of astronomy, not just indirectly through better instruments etc., but very directly by providing platforms in space for telescopes, away from the "noise" of earth. The Einstein Observatory and the planned Space Telescope are examples of this very substantial contribution.

300. Apart from radio emissions, certain other terrestrial activities are likely to cause irreparable damage to the earth's environment unless checked in time. A major concern is the use of chlorofluorocarbons (CFCs) for various purposes, possibly resulting in the depletion of the ozone layer. While the effects of this are being studied, existing research already indicates some depletion in the protective ozone layer with possible health and biological hazards to human, plant and aquatic life due to increased ultra-violet radiation. Within the framework of UNEP, the risks of such depletion have led to a decision by UNEP (EC-9) to start work on a global framework convention for the protection of the ozone layer. An ad-hoc legal and technical expert group has recently initiated its work on this matter. The function of monitoring ozone depletion is therefore of obvious importance, and space technology - through satellite and rocket borne sensors - is contributing substantially in this. A well-maintained, regularly calibrated ground network is also of great importance and efforts must be undertaken to increase the quality and spatial spread of observations. In this context, the research being undertaken by various countries - with the co-ordination and assistance of WMO and UNEP - should be

encouraged. Specifically, an integrated global ozone observing system should be created, under the aegis of WMO and UNEP (as recommended by the UNEP Co-ordinating Committee on the Ozone Layer).

301. While space activities have given rise to some concern about their effects on the environment, they have also contributed very substantially to the monitoring of these - and other - effects. Environmental monitoring satellites will contribute increasingly to providing information about pollution on earth as well as in its immediate environment. However, action on this information has to be instituted in good time, especially because of the cumulative - and sometimes irreversible - effects that may be caused. Since such changes affect all mankind, the international community must together take action as required. Such world-wide monitoring of the earth's environment and necessary remedial action should be co-ordinated by UNEP which is already undertaking, within the framework of its Global Environment Monitoring System (GEMS), various activities in this field. All countries should promptly provide all relevant data required for such monitoring purposes to UNEP.

### I. Implications of projected developments in space technology

302. The next quarter century is likely to see a growth in space technology and applications surpassing even the phenomenal progress of the last 25 years. These advances bear the promise of great benefits for mankind; unfortunately, however, some of the potential developments could also pose serious hazards. Also, depending upon how many of the applications are organized, they could lead to a skewed distribution of benefits between countries - accentuating, thereby, the existing inequities in the world economic scene. However, appropriate and co-operative actions by States - individually and acting in concert - could lead to a happier situation of more widely-shared benefits. Even if this is not completely possible, an understanding of the technical, economic and social implications of likely future developments could help in achieving this desired goal.

#### 1. Space solar power systems

303. Among the major new applications of space technology, probably none has drawn as much attention as proposals for a space solar power system (SPS). This visionary concept, first put forth in the United States, may be particularly relevant in the context of growing world-wide energy needs and dwindling conventional resources (oil, coal, wood). Though its actual realization would involve efforts and finances far surpassing any that man has yet undertaken, this is not an impossible task, nor do there seem to be any technological obstacles that could not be surmounted in the next two decades or so, if the effort is undertaken. However, there are some doubts about the economics of such a venture, and it is unlikely to be worthwhile unless there are some major technological breakthroughs.

304. Even though SPS is unlikely to be a reality before the end of this century, it is well to keep in mind the implications that it could have. The effects on the environment due to frequent launches of the very large rockets

required for the construction of such a system could be a cause for concern (see section H above). Should microwaves be considered for power transmission, their biological effects may also be a cause for concern because of the lack of precise knowledge about the effects - especially the long-term effects - on man; and their potential effects on the ionosphere also warrant further studies. Interference with radar and communications systems could, however, be a problem if microwave transmission is used, due to the very large power of the SPS transmitter, which would produce RF noise almost all over the spectrum. A concerted research and technology development effort would be required to resolve some of these problems.

305. As mentioned earlier, the economics and advantages of SPS relative to other methods of energy production, is by no means yet established. However, if - and when- technological break-throughs should change this situation, and provided that the previously mentioned implications are solved to the satisfaction of all countries that may be affected, SPS would be an ideal project for co-operative international effort: its magnitude, technological challenges, financial and material requirements, its potential benefits, and its vulnerability would make intenational effort not only worthwhile, but probably also necessary. The feasibility of undertaking a joint internatinal effort should therefore be examined and - as a corollary - the means of sharing internationally the benefits that result. While the SPS may yet be in the distant future, it is advisable to initiate such efforts now, so as to try and evolve a harmonious mechanism for international paticipation and co-operation.

## 2. Space manufacturing

306. [Manufacturing of materials in space, using terrestrial or extra-terrestrial raw material, is another promising area. A number of countries (including the Federal Republic of Germany, France, Italy, the USSR and the United States) are continuing experiments in materials processing - using both rockets and space stations - in the special micro-gravity and high vacuum conditions available in space. Research on a "mass-driver" for sending materials from, for example, the moon to a space station, was begun several years ago in the United States. Crystal growth, synthesis of materials and other manufacturing experiments may lead to a "space industry" in these areas in the future. While such commercialization of these processes could lead to scientific insights, new materials and higher quality or lower cost of existing materials, the benefits of these would be available mainly to those who can make the necessary investments in such space technologies. International mechanisms might have to be formulated to ensure that benefits from such developments are available to all nations. Clearly, there is scope and need for international co-operation, to assuage the worries of non-space nations as well as to share, to the extent possible, the risks and investments of any large-scale space manufacturing.]

307. With regard to the use of extra-terrestrial material for space processing, or for use on earth, note should be taken of the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (this Agreement is not yet in force).

[illegible]. The special environment of space is also being used to carry out scientific studies with regard to metallurgy, fluid dynamics, chemical reactions, etc., and also for various biological experiments. Co-operation, and exchange and dissemination of scientific results in these fields should be encouraged.

### 3. Communications and remote sensing

309. Future developments in certain existing applications - particularly communications, broadcasting and remote sensing - hold out great promise but also have the potential to cause serious problems. In broadcasting, for example, the development of very powerful satellites will soon make is possible to broad- cast radio or television programmes directly to home receivers. This could be a tremendous means of spreading education and disseminating information, especial- ly in developing countries which now have very poor means of communication. Unfortunately, broadcasting via satellites could also have negative effects in various fields.

310. COPUOS has examined these issues at length and in great depth. It may now be time for countries to agree, as soon as possible, on the legal implications of remote sensing of the earth from space and on principles governing the use of artificial earth satellites for direct television broadcasting.

### 4. Search for extra-terrestrial intelligence

311. The search for extra-terrestrial intelligence (SETI) is, in a way, more a philosophical quest rather than a technical one; its implications are, therefore, of a very basic and deep kind. This is an activity that combines the most sophisticated technology of space with the age-old spiritual and philosophical concerns of man. The immediate relevance and priority for such a search can obviously be questioned, yet this is so basic an issue that we can well afford to use a part of our resources on this investigation. To the extent that this quest is of relevance to all mankind, it is necessarily global in interest. It should therefore be considered a joint international effort, with each country contributing whatever it can.

### 5. Space settlements

312. For the more distant future, certain scientists have proposed the setting up of settlements in space - either in orbiting space stations or on celestial bodies. These concepts have given rise to many technical studies and, in fact, there now exist fairly detailed conceptual visions for such settlements. Some research and studies have, for example, been carrried out on self-sustaining systems and concepts based on recycling. While there is little likelihood - and less immediate need - of such space settlements in the next few decades, this may yet be an idea meriting continuing study, especially if materials processing in space or SPS become realities.

## 6. Conclusion

313. The rapid advances in space technology continue to give rise to romantic visions of new worlds, new frontiers and new possibilities. While these are generally beneficial, many of them have side-effects which are of concern to all nations. Also, some of the new developments could have negative social and economic implications, especially for developing and non-space nations. Thus, while advances in space technology are to be generally welcomed, their implications need careful consideration and dissemination so as to catalyse appropriate international action. Since many developing nations do not always have the technical expertise to assess these implications for themselves, the United Nations - in association with concerned specialized agencies - should organize periodically such studies to examine all the global implications - technical, social, economic, environmental and legal - of new space developments, especially for developing countries. However, studies on matters within the competence of a specialised agency should be carried out by that agency.

## III. INTERNATIONAL CO-OPERATION AND THE ROLE OF THE UNITED NATIONS

### A. Multilateral co-operation

314. Co-operation between nations on matters concerning space has a long and rather fruitful record, though recent trends of increasing military activities in space are a cause of great concern to almost all nations. It is hoped that space does not become a new arena for rivalry between nations - not only for the sake of continuing peace, but also as a stiumulus to development. There are few fields of human endeavour where the need for co-operation is more esential and the pay-off greater. In fact, it is the recognition of this necessity and benefit that has led to such very successful examples of co-operation as the operational international communication and meteorological data systems. Space activities have shown a way of how different countries, with widely varying political systems, levels of development, and culture can work together for mutual benefit.

#### 1. Programme on International Co-operation in the Study and Peaceful Utilization of Outer Space (INTERCOSMOS Programme)

315. A programme of co-operation amongst socialist countries in the peaceful exploration and use of outer space was proposed by the USSR in 1965. Following an understanding on this proposal, a programme of multilateral co-operation was adopted in 1967 and, in 1970, given the name INTERCOSMOS. In 1976, as a consolidation of their favourable experience, the nine countries then participating in the programme signed an intergovernmental "Agreement on Co-operation in the Peaceful Exploration and Use of Outer Space". This Agreement is open to accession by other countries interested in co-operating in the investigation of space, subject to the consent of the contracting parties. In 1979, a tenth country acceeded to this Agreement.

316. The INTERCOSMOS programme embraces joint activities in the following basic areas:

(a) Study of physical properties of outer space;

(b) Space meteorology;

(c) Space biology and medicine;

(d) Space communication;

(e) Study of the natural environment by remote sensing.

317. Co-operation in the INTERCOSMOS programme is conducted in the form of joint development of scientific instruments and service systems and their integration into satellites, other space vehicles and research and meteorological rockets, and also in the form of joint research, experiment-design, methodology development, and joint analysis of data. One of the features of INTERCOSMOS co-operation is the absence of a common budget which would restrict

the scope of joint work in space research. Every country finances the development of scientific instruments and the implementation of experiments in which it is interested. The Soviet Union provides to its partners in co-operation the facilities of space rocket technology and ensures the launching of space vehicles. Scientific results of joint experiments form a common asset of all parties to the work done and are accessible to the international scientific community.

318. From October 1969 to December 1981, 22 INTERCOSMOS satellites, 10 high-altitude research rockets and a large number of meteorological rockets have been launched for various studies. In addition, instruments developed within the framework of the INTERCOSMOS programme have been mounted on a number of space vehicles launched by the USSR as part of its national programme.

319. As an important part of the INTERCOSMOS proramme, international crews have worked on-board Soviet spaceships - Soyuz and Salyut-6 - and from March 1978 to May 1981, nine international space crews have been orbited. During these flights, international crews carried out about 150 experiments in the fields of space biology and medicine, materials science, space and atmospheric sciences and remote sensing of the surface of the earth.

320. The INTERCOSMOS programme demonstrates the feasibility of countries at ferent levels of economic and technological development co-operating in space activities.

## 2. European Space Agency (ESA)

321. ESA was established in 1975, combining the activities previously embodied in two other European organizations, set up for developing scientific satellites (European Space Research Organization - ESRO) and launch vehicles (European Space Vehicle Launcher Development Organization - ELDO). This intergovernmental organization has as its purpose the promotion, for exclusively peaceful purposes, of co-operation among European States in space research, technology and applications. The Agency has 11 member States, two associate member States and a special co-operation agreement with a non-European State.

322. The ESA budget is financed by its member States, with contributions for mandatory activities (including the general budget and the scientific programmes) based on national incomes, and contributions to optional programmes on a flexible basis. The bulk of the contributions are paid out by ESA to European aerospace industries, with the industrial work being shared in a manner commensurate with the financial contributions of each member State. This helps to attain one of the goals of ESA: improving the competitiveness of European industry.

323. The ESA programme includes scientific satellites, applications satellites · communication, meteorology and remote sensing, and rocket development - culminating now in the development and successful launchings of Ariane. The programme also includes SPACELAB (to be launched by the United States Space

Shuttle), which will enable European astronauts to carry out research in space. Several of the Agency's programmes involve close co-operation with NASA, including especially the SPACELAB and Space Telescope programmes.

324. The scientific programme includes study of the earth's environment and also of celestial objects. The application programme includes both earth observation and communication. The former includes METEOSAT (Europe's contribution to WWW and GARP), SIRIO-2 (for meteorological data distribution and clock-synchronization by means of laser techniques) and remote sensing, involving a network of data reception and dissemination stations (EARTHNET), remote sensing payloads on SPACELAB and satellite systems for ocean-observation and land applications.

325. The communications programme led to the development of the OTS satellite in 1978 following the Symphonie satellite (a joint venture by the Federal Republic of Germany and France) and the Italian SIRIO satellites. The next generation will be the European Communication Satellites (ECS), five of which will be supplied to the European Telecommunications Satellite Organization (EUTELSAT). A derivation of the ECS - called MARECS - will provide maritime communication; the first two satellites of this series are being leased to INMARSAT. In the area of broadcasting, the L-SAT programme aims at providing a direct-to-home television capability, so that television broadcasts can be received using a 1 metre diameter antenna and a converter adaptable to conventional television receivers.

326. Development of the Ariane launcher has been a major programme of ESA and its successful flights have now established its capability. A programme for further development of Ariane, to enable it to launch even heavier payloads, is already under way.

327. ESA is an example of regional pooling of resources to achieve objectives and develop capabilities that are beyond the reach of individual nations. While the member States are all developed countries with substantial technological and industrial infrastructures, the basic principle of pooling resources to achieve otherwise unattainable objectives could also be adopted by groups of developing countries.

### 3. International Telecommunications Satellite Organization (INTELSAT)

328. An example of multilateral intergovernmental co-operation is the INTELSAT system. Established in 1964 - within a few years of the dawn of the space age and very soon after the feasibility of geostationary communication satellites was first demonstrated - this organization has seen phenomenal growth. Begun by 11 nations, it now has 106 countries as members and serves over 130 countries and territories. While the satellites and associated facilities are owned by INTELSAT, the earth stations and links are owned by individual countries. At present, INTELSAT has 13 satellites in orbit, and over 240 earth stations are using them. Full-time telephone channels have grown from 75 in 1965 when the system began operation, to over 20,000 in 1980. At the same time, despite

continuing world-wide inflation, the space segment charge for full-time voice circuits has been reduced from U.S.$ 32,000 per year in 1965 to U.S.$ 4,680 in 1981. INTELSAT also leases capacity for domestic use, and some countries are using INTELSAT satellites for intra-country communication; many others are planning to do so. INTELSAT will also lease three (and possibly more) maritime communications satellite subsystems to INMARSAT (see paras. 338 to 344 below).

329. In 1978, the INTELSAT Assistance and Development Programme was established to help achieve more effective utilization of INTELSAT facilities. The assistane is normally provided on a free-of-charge basis, generally on a first-come, first-served basis. Where the assistance requested would require more than two man-months of effort or extensive outside consultant services, the request would be considered on the basis of a cost-reimbursement contract or, alternatively, would be presented to the Board of Governors for approval.

330. Apart from the important role it has played in international communication and the stimulus it is trying to provide to domestic satellite communication through leased capacity, INTELSAT has been instrumental in the rapid advancement of space technology, both through its own work and by placement of development contracts. In placing contracts, it has also attempted to involve industries from several countries - though success in this has necessarily been limited because of the technological and infrastructural onstraints in most countries.

331. INTELSAT is in the process of forging formal links with other international organizations - especially ITU, INMARSAT, IMCO and the Asia Pacific Telecommunity (APT). It also submits annual reports to the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS).

332. It is interesting to note that a majority of the INTELSAT members and users are the developing nations, and to this extent INTELSAT has helped to spread the benefit of space technology to developing nations. It is also likely that no single nation would have felt the need for such a world-wide system - it would, in any case be very expensive. What has made it necessary and worthwhile is the participation of a large number of nations.

333. Similarly, there are other applications of space technology that may not be so attractive for individual countries, but would be very beneficial if nations got together and co-operated. In this regard, the organizational structure of INTELSAT, which provides, in particular, for the participation of both governmental and non-governmental entities, may merit close study as one possible model for other such ventures.

### 4. International System and Organization of Space Communications (INTERSPUTNIK)

334. Work in the field of space communications as part of the INTERCOSMOS rogramme led to the creation in 1971 of INTERSPUTNIK. It was created to meet the need for exchange of radio and television programmes, telephone and telegraph links and other types of information between different countries.

Currently, INTERSPUTNIK has 12 members. Any State that shares the goals and principles of INTERSPUTNIK activities and assumes the obligations under the Agreement may become a member.

335. INTERSPUTNIK currently operates using Soviet satellites on a lease basis. All earth stations are nationally owned. Two STATSIONAR satellites in geostationary orbit are being used and 13 ground stations in 12 countries operate as part of the system; more earth stations in other countries are also planned. In addition to members of the organization, other countries also use channels of the INTERSPUTNIK system.

336. The INTERSPUTNIK system is used mainly for exchange of television programmes, in which more than 20 countries participate. About the same number use its channels for international telephone and telegraph links.

337. INTERSPUTNIK has concluded agreements with various international organizations and with INTERCOSMOS participants, identifying specific areas and forms of co-operation. It also co-ordinates its activities with ITU and other international organizations regarding frequency spectrum, standards, etc.

### 5. International Maritime Satellite Organization (INMARSAT)

338. In November 1973, the Assembly of IMCO decided to convene an international conference to consider the establishment of an international maritime satellite system. Accordingly, an International Conference on the Establishment of an International Maritime Satellite System was convened in April 1975. After three sessions, the Conference adopted in September 1976 the following two instruments:

(a) Convention on the International Maritime Satellite Organization (INMARSAT);

(b) Operating Agreement on INMARSAT.

339. The main purpose of INMARSAT is to make provision for the space segment necessary for improving maritime communications; it shall act exclusively for peaceful purposes. INMARSAT is open to all States for membership. In addition, ships of non-members may use the space segment on conditions determined by the Organization. By January 1982, 37 States had become Parties to the Convention, and others are in the process of joining.

340. INMARSAT is financed by the contributions of its signatories, each in proportion to its investment share, which is intended to reflect the actual utilization of the INMARSAT system. At the outset, it will provide services such as transmission of distress messages, distribution of urgency and safety messages, public correspondence by telex and telephony, and data transmission. Later, after appropriate agreements and co-ordination with other international agencies and technical developments, it will provide other services such as safety advisory messages, navigation and automatic warning of navigational

hazards, etc. The International Conference on the Establishment of INMARSAT also recommended a study on the use by INMARSAT of multipurpose satellites providing both maritime and aeronautical services. Studies aimed at integrating land-mobile services are also proceeding in INMARSAT. In adopting the INMARSAT Convention, Governments envisaged that there would be a need for a satellite navigation system and provided accordingly in defining the purposes of the organization.

341. The organizational structure of INMARSAT, which is similar to that of INTELSAT, comprises three organs: the Assembly, in which all Member States are represented and have equal votes; the Council, a smaller body of 22 signatories, with the voting power of each being equivalent to their investment share; and the Directorate, which is the executive organ.

342. While INMARSAT provides the space segment - the satellites and related tracking, telemetry, command and control facilities - ship owners are responsible for the shipborne stations. The coast earth stations and landline connexions are the responsibility of the countries concerned. Three coast stations were in operation in 1981, another 8 are scheduled to be operating in 1982 and 12 more are planned by 1985. By the end of 1981, about 1000 vessels were equipped with shipborne terminals; this number was expected to go up to 1,600 by 1985 and to 2,200 by 1988; however, these forecasts are now considered conservative. INMARSAT began operation in February 1982, using satellite capability leased from the United States (MARISAT), ESA (MARECS) and INTELSAT.

343. INMARSAT works in close co-operation with a number of international organizations, including the United Nations, ITU, IMCO, WMO, INTELSAT and ESA. In particular, it has established and is maintaining co-ordination and consultations with IMCO on the development of the Future Global Maritime Distress and Safety System.

344. INMARSAT provides another example of co-operation in space and the benefits that result. It has the unique feature of combining public service (safety and distress messages) with a revenue-earning objective. It also provides a model of an organizational sructure and a financial mechanism for such international ventures. (For further details regarding INMARSAT, see A/CONF.101/BP/IGO/2.)

### 6. Arab Satellite Communications Organization (ARABSAT)

345. ARABSAT was founded in April 1976 by the countries of the Arab League. It has 21 States as members and its headquarters is located in Riyadh, Saudi Arabia. The main objective of ARABSAT is to establish, operate and maintain a telecommunication system for the Arab region. It will complement the terrestrial network for routing regional telecommunication traffic and provide new possibilities for television programme exchange between Arab countries. The system will be equipped to provide:

(a) Regional and domestic telephony, telegraphy, telex and data transmission;

(b) Regional and domestic television;

(c) Community television.

346. The space segment will include two satellites in geostationary orbit and a third one as a spare. The control centre will be at Riyadh. It is planned to bring the system into use by 1983. (For other details regarding ARABSAT, see A/CONF.101/BP/IGO/4.)

347. ARABSAT is the first such co-operative venture by developing countries and is aimed specifically at providing the operational benefits of space technology to its Member States. Not only does this co-operation result in sharing costs - thereby increasing the economic attractiveness of the system for each country - but it will also result in developing closer links and greater understanding amongst its Member States. Other developing countries may like to study the system closely from the point of view of determining the feasibility of similar co-operation in their region.

### 7. European Telecommunications Satellite Organization (EUTELSAT)

348. The Interim EUTELSAT is a provisional European organization created in June 1977 by a number of European telecommunications administrations in order to establish and operate space segments of European satellite telecommunication systems. It has at present 20 members. The primary objective is the construction, establishment, operation and maintenance of a European space segment for regional or domestic fixed services such as telephony, telex and data transmission as well as sound radio or television transmissions. The first generation of satellites will be procured and launched by ESA and placed in orbit as from 1982. It is intended that a definitive European telecommunications satellite organization based on an intergovernmental treaty shall replace the present Interim EUTELSAT organization.

### 8. Other multilateral co-operation

349. Besides the organizations described in the preceding paragraphs, a great deal of multilateral co-operation takes place through other bodies or through special arrangements. There exist, for example, regional broadcasting and telecommunications bodies, remote sensing councils, etc. which provide fora for multilateral co-operation. There are also efforts under way to esbablish regional space agencies, and some regional remote sensing centres already exist. In addition, a great deal of multilateral co-operation takes place around specific programmes. Examples of this include the LANDSAT Ground Stations Operators Working Group and a similar group to be set up for SPOT; discussions on compatibility and complementarity of satellite systems between various satellite operators; co-operation with regard to scientific missions - e.g., the proposed European, Japanese, Soviet and United States missions to Haley's comet - and applications programmes - e.g., the search and rescue system involving Canada, France, the Soviet Union and the United States. Such co-operation has proven to be extremely useful and has led to better scientific understanding of various phenomena at a lower cost. This tradition of

co-operation in scientific ventures has, of course, been long-standing and is articularly exemplified by such programmes as the International Geophysical Year, the International Quiet Sun Year, GARP, the Monsoon Experiment (MONEX), etc. It is desirable - and even necessary - that such extensive and on-going co-operation now take place in the field of applications also. Not only would this provide benefits to all countries - developing and developed - but would also create greater understanding between nations and a better international climate.

350. Non-governmental bodies such as the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU), and the International Astronautical Federation (IAF) have also played important roles in encouraging and organizing scientific meetings, dissemination of scientific data, etc. (For an elaboration of their role, see A/CONF.101/BP/12.) Both COSPAR and IAF enjoy observer status with COPUOS and have been commissioned from time to time to carry out studies and prepare reports for its consideration. They provide an extremely useful mechanism by which expertise from many countries can be tapped and international teams of experts can be assigned to prepare reports or conduct studies. The special character and effectiveness of these non-governmental scientific organizations depends upon their widespread membership. In view of this and their positive contribution, it is desirable that all countries might support the participation of their scientists and relevant institutions in these organizations.

351. Space is the common environment of all mankind. Our well-being and very survival depends upon the state of the environment. Studying it, understanding :, monitoring and maintaining the delicate balance between its various constituent elements, are all necessary activities that are of global interest. Weather forecasting, monitoring of pollution, ensuring safety at sea, enabling people to see and talk to each other, the fact that combination of two separate scientific observations is greater than the sum of the parts - all these dictate the need for making space an arena of international co-operation.

## B. Bilateral co-operation

352. Bilateral co-operation between countries in the field of space is widespread and has had very successful results. It constitutes a major segment of international co-operation in the peaceful uses of outer space. A partial list of activities fostered through such co-operation includes:

(a) The provision of a launch for satellites;

(b) The "loan" of an orbiting satellite or of part of its capacity;

(c) The loan of ground equipment;

(d) Providing sounding rockets for scientific experiments;

(e) Providing tracking support for spacecraft;

(f) Permitting the reception of data;

(g) Exchanging or providing scientific and other data;

(h) Providing training facilities;

(i) Providing advice and consultancy;

(j) Joint planning, development and manufacturing of space systems;

(k) Integrating payloads/experiments of one country in the other country's satellites/space vehicles;

(l) Rendezvous of space vehicles;

(m) Complementary space missions;

(n) Joint flights by cosmonauts from two countries on space stations of one of these countries.

353. This list - merely representative and not exhaustive - is indicative of the very wide range of bilateral co-operation that has and continues to take place in the field of space. Such co-operation extends from basic science to operational applications; it includes co-operation between developed countries, and between developed and developing countries. For example, the United States has entered into more than 1,000 bilataral agreements with over 100 countries, both developing and developed. However, as there has been little or no bilateral co-operation between developing countries, it will be necessary to structure appropriate mechanisms for co-operation between them. There is both need and scope for this and, in view of its importance, this aspect is discussed in greater detail in a separate section (see section D below).

354. Bilateral co-operation between nations with advanced capabilities in space technology and some developing nations has had very beneficial results. It has often begun the processes of space technology development and application in some developing countries and has, in many cases, led to demonstration or experimental projects in space applications and science. Such demonstration projects have been of great importance for the adoption of various space applications in developing countries.

355. Some developed countries have also provided training opportunities to scientists, engineers and technicians from developing countries in space science and technology, and also in related fields. This training and work experience has often been instrumental in developing a core of experts who have been the backbone of their country's space programme.

356. Bilateral co-operation between developed countries has also been very productive. It has enabled a pooling of skills and a sharing of costs, to mu-

tual advantage. It has resulted in development of new technologies and systems, and to this extent such co-operation has benefited developing countries also.

357. The extent and examples of bilateral co-operation are so very numerous that they cannot be summarized easily in a report of this type. While some details of such co-operation are outlined in the national papers of various countries, it may suffice to note here that almost every country participating in any form of space activity has been involved in co-operating with others in one way or another. It is important that such co-operation not only continue, but be intensified.

## C. An assessmement of multilateral and bilateral co-operation

358. An over-all assessment of multilateral and bilateral co-operation in space - described briefly in sections A and B above - indicates a rather positive picture and many concrete achievements. Nevertheless, it seems clear that the full potential of the exciting possibilities opened up by space technology has not yet been tapped. More extensive co-operation, and more co-operative projects aimed at specific problems, are necessary. Greater benefits from space can be derived by intensifying international co-operation, and in this the technologically-advanced nations have a special responsibility.

359. Co-operation in space could cover a wide range of activities including the following, some of which are already being carried out:

(a) Setting up and operating regionally or internationally-owned systems or promoting continued co-operation among satellite operators in areas such as communications, remote sensing, meteorology, geodesy, etc.;

(b) Creation of mechanisms for assuring international availability of space-derived data in fields such as meteorology, remote sensing, geodesy, etc.;

(c) Co-ordination of national, regional and international systems so as to prevent interference, especially in communications and broadcasting;

(d) Co-ordination between programmes and systems so as to maximize benefits by making systems compatible with each other and complementary to the extent possible, especially for meteorology and remote sensing;

(e) Joint planning of scientific missions and general dissemination of scientific data to all countries;

(f) Provision of opportunities and facilities by space-nations to all other nations, so that the benefits of space technology are available to all. This could include the integration of experiments/payloads in spacecraft or rockets, launch of satellites, loan of satellite capabilities for experimentation/demonstration, etc.;

(g) Provision of learning and educational opportunities; joint development and sharing/transfer of technology; exchange of experiences and specific data, etc.;

(h) Assistance in the creation of necessary infrastructure for space as appropriate for each country;

(i) Further development of international space law concerning the use of space technology and its peaceful applications.

360. [While some of these activities may seem rather ambitious, international co-operation has already resulted in the fulfilment of some. For example, there have existed for some time operational systems for international communication (INTELSAT and INTERSPUTNIK), and co-ordination with regard to the geostationary orbit, including use of the RF spectrum, is adequately taken care of through ITU. In the field of meteorlogy, WMO has evolved an international co-operative programme of satellite observation and data dissemination that is functioning smoothly and well, and - at the recommendation of COPUOS - two centres for remote sensing have been set up in the United Nations system (in FAO and in the Department of Technical Co-operation for Development). COPUOS has initiated a number of treaties etc. that are now part of international space law. Similarly, there exist examples of co-operation that meet some of the goals listed under each of the items mentioned above. However, in order for the benefits of space technology to be fully exploited and particularly to be more widely available, there is need for a great deal more to be done. In many important fields - e.g., remote sensing - co-ordination has not yet been fully achieved, and there is need for a sense of urgency.]

361. While the benefits from space technology can be substantial, the investment called for is sometimes large and often beyond the means of a developing nation. Therefore, if developing nations are to maximize the benefits they derive from space, it is necessary to devise ways of sharing the large investment costs. The feasibility of this approach has been demonstrated at the international level by INTELSAT, INTERSPUTNIK and INMARSAT and at the regional level by ARABSAT, EUTELSAT and ESA. Multilateral and bilateral co-operation could result in similar systems in other fields - allowing countries to utilize space technology without themselves making very large investments. These possibilities are promising and merit further study, as has been recommended in paragraphs 224, 227, 230, and 231 of Chapter II.

362. However, paucity of funds is not the only constraint inhibiting developing countries from greater utilization of space technology. Two other major - and related - limitations are the shortage of adequately trained manpower and a lack of industrial and research infrastructure. While the major efforts in these fields have obviously to be undertaken by the country concerned, co-operation with other countries can do a great deal to accelerate progress in these areas. Existing co-operative arrangements have undoubtedly provided some help to many countries. However, it is clear that these efforts need to be intensified in the face of a problem of such magnitude. As discussed, intensive co-operation between countries is an essential element in developing

adequate technological capability - both human and material - in each country. The exchange of experiences is more meaningful and relevant if it takes place between two developing nations, rather than from a developed to a developing one. Such exchanges between developing countries must, therefore, be encouraged. In view of the importance and potential of co-operation between developing countries, this issue is discussed in greater detail in a separate section.

363. Though a start has been made in many regions, the extent and depth of regional co-operation in space is yet rather meagre. ESA and INTERCOSMOS provide the only examples of organized, ongoing multilateral co-operation between groups of countries in the field of development and application of space technology, while ARABSAT and EUTELSAT provide examples of regional co-operation for the establishment of an operational system. There is some regional co-operation among other groups of countries (e.g., the African Remote Sensing Council, regional remote sensing centres, proposals for the African Satellite System for Common Carrier and Broadcasting Communication (AFROSAT) and for a Latin American remote sensing system, co-operation of the Association of South-East Asian Nations (ASEAN) regarding the use of Indonesia's PALAPA satellites, etc.) - however, little progress has been made towards operational systems except in the case of PALAPA. Clearly a great deal more needs to be done.

364. The creation of appropriate co-ordinating and regulatory mechanisms and the elaboration of "space laws" to ensure the smooth and orderly growth of space technology and applications are functions that have been performed basically under the aegis of the United Nations and its related agencies. The specialized agencies - ITU, WMO and IMCO in particular - have played a vital role in co-ordination and regulation, while COPUOS has served as the focal point for United Nations activities in the field of space. COPUOS and its two sub- committees have been instrumental in the elaboration of space laws and treaties. The United Nations system has contributed much to fostering co-operation in space; its role is dealt with more extensively in section E below.

365. In the context of international co-operation in space, it may be worth pondering over some of the lessons that have been drawn by some countries with active co-operative programmes. These may be summarized as follows:

(a) Co-operation must be the result of agreed means to reach a common goal or of complementary goals; these must be based on real needs and priorities of the countries concerned;

(b) Due regard must be paid to cultural, social, technological and economic differences, and particularly to administrative and organizational differences, between co-operating countries; however, fruitful co-operation is possible even in cases where such differences are substantial;

(c) Co-operation must bear promise of benefits to all parties concerned;

(d) Co-operation, to be genuine and fruitful, requires that each party make a tangible contribution;

(e) Commitment to the ideals and benefits of co-operation among all concerned is essential, as is at least some degree of personal rapport at the operational level;

(f) Greater benefits are derived from co-operation which involves sharing of experiences and learning together rather than donor-recipient "co-operation" situations;

(g) Co-operation usually intensifies and becomes more productive as countries working together over a period of time discover the benefits of working together, and develop efficient mechanisms for doing so.

366. While these insights obviously cannot be universally true in all situations, they may serve as useful guidelines to start with.

## D. Co-operation between developing countries

367. The developing countries - despite their widely varying levels of economic, scientific, technological and industrial development - recognize the similarity of their problems and the complementarity of their needs and resources. Their widely varied levels of scientific, technological and industrial development, can, in fact, provide the basis for mutually beneficial -operation in space applications, technology and science. Developing countries with greater experience in a particular space application, or with greater scientific and technological capability in a given field, can help other developing nations which may only now be getting into these areas. It is therefore highly desirable that developing nations get together and co-operate with each other, so as to collectively make the most of what they have.

368. While satellites operate in a common "neutral" environment, the ground equipment - which often forms a larger part of the total investement - has to operate in varying climatic and cultural environments. Equipment developed in and for developed countries is not always suitable for the physical environment of developing countries, and is even less suitable for their cultural environment: the way it is handled, carried, operated, etc. is generally somewhat different. In this reqard, equipment developed by a developing country is more likely to be relevant and suitable for the total environment of another developing country. Efforts should therefore be made - both by the countries concerned and by international agencies - to encourage the flow of equipment made by developing countries to other developing countries.

369. The above argument is equally applicable to "environmentally-suitable" experts. Experience has shown that an expert from a similar socio-economic and physical environment is likely to adapt quicker and work better in a foreign country. His experience is often more relevant and his recommendations generally more practical. Developing countries might, therefore, find it to their mutual advantage to seek and provide expert assistance - when required -

from and to each other. National and international funding and technical assistance agencies, when providing expertise assistance, might first seek the necessary experts from developing countries.

370. For historical and other reasons, users from developing countries are more familiar with the equipment and expertise available in the developed nations rather than in other developing countries. It is necessary to increase, in developing countries, knowledge about the work being done and expertise available in other developing countries. To facilitate this, it is extremely important that developing countries should promote exchange of information and visits of scientists, technologists and decision-makers amongst themselves.

371. In this context, the global network for exchange of scientific information, recommended by the Conference for Science and Technology for Development, in its Vienna Programme of Action on Science and Technology for Development, should play an important role and should be given urgent consideration.

372. One problem faced by many developing countries - and small countries in particular - is the high cost of maintaining large inventories of spares for their limited operational facilities (e.g., satellite communication earth stations). As a result, critical spares are sometimes not available, leading to a system breakdown. Rather than maintaining large inventories for just one or a few facilities, it would be far more economical to have a joint regional store for selected critical but expensive spares. This would reduce inventory costs and at the same time reduce system down-time also. While the initiative to organize such regional stores must come from the countries concerned, they should be provided all possible support and encouragement by international agencies. [It is desirable that the United Nations system provide technical assistance - if required - to decide on the particular parts/ components and their quantities to be maintained in the regional stores.]

373. Collectively, the developing countries have between them accumulated a vast amount of experience in a wide array of space applications. They also have a great deal of experience in non-space areas relevant to space applications - e.g., photo interpretation, broadcasting, etc. - and on a variety of equipment. However, there has so far been very little exchange of this experience between the developing countries - especially on specifics like performance and problems of a particular piece of equipment in a particular operating mode and environment. Clearly, such information would be invaluable during planning, procurement and operation/maintenance. The United Nations and concerned specialized agencies should examine how best to organize the collection, collation, documentation and dissemination of such experience.

374. Concrete and mutually beneficial co-operation between developing nations need not be restricted merely to the exchange of information, experts and experiences, or to regional stores of spares; it can extend much further - even to jointly owned and shared ground and space hardware. While there are already some positive examples (see para. 363), such co-operation needs to be carried further and extended to more countries. The establishment of regional space

agencies by groups of developing countries - as proposed for Latin America, for instance - could provide an effective mechanism for co-operation and a significant impetus to the use of space technology. Such initiatives should therefore be encouraged. The United Nations system and its regional economic commissions could play a supporting role in these initiatives.

375. Developing countries should take concrete steps to conceive, initiate and implement specific co-operative programmes among themselves on a regional, bilateral or multilateral basis. Such programmes can be of considerable mutual benefit in almost all fields of space applications - including communications, broadcasting, remote sensing, meteorology and navigation. Such co-operation could range from regional receiving stations for remote sensing data to joint ownership of complete systems. Cost-sharing and the use of complementary resources of the countries involved will result in far better cost-benefit ratios, while simultaneously helping to develop the infrastructure in these countries. At the same time, as in the case of ARABSAT, EUTELSAT, INTELSAT and INTERSPUTNIK, it is possible to devise appropriate organizational mechanisms combining joint ownership of one part of the system (e.g., spacecraft) with national ownership of other parts (e.g., earth stations).

376. Since the technical and economic advantages of jointly-owned systems are already obvious in many situations, the developing countries should, through an act of political will, take steps to implement such co-operative programmes. Where necessary, the United Nations and its specialized agencies should be provided with the means to fund expert missions to define specific, need-based, co-operative programmes between groups of developing nations.

377. While short-term and immediate benefits from space technology can be reaped by outright purchase of systems and turn-key contracts, including operation of facilities, in the long run it is obviously desirable - even essential - for each country to have its own pool of knowledgeable experts. The size of this pool, the depth of knowledge and breadth of disciplines required, would obviously vary from country to country. Training and education are therefore essential ingredients in any long-range plan for beneficial applications of space technology. Developed countries do have the best equipped, and often best run, training/educational facilities. However, these facilities often do not have the specific purpose of providing training and education compatible with the needs of developing countries. Therefore, the experience gained in such institutions is often not relevant for developing country situations. There are now, in some developing countries, at least a few centres which can provide training or on-the-job experience that is of high quality and of far greater relevance to developing country situations. This is because of the similarity of situations and problems in developing countries, making work-experience gained in a developing country more useful than similar experience gained in a developed country. Thus, it would be most useful if developing countries with active programmes of space applications would provide on-the-job experience or training opportunities to persons from other developing countries. Such co-operation should be actively encouraged by the United Nations and its specialized agencies by providing available assistance, *inter alia*, funding for fellowships.

378. For many years the concept of technical co-operation between developing countries has been discussed extensively and was given special attention in the TCDC Conference in Buenos Aires in 1978. The implementation of this concept is still in the early stages and the important field of space applications presents another opportunity to put this idea into practice. If developing nations do not want to be denied the fruits of space technology, if instead they would like to use it as another means of accelerating development, then it is imperative that they take steps to work co-operatively and to derive the maximum benefit by pooling their limited resources. The recommendations in this section are an attempt to provide concrete shape to this desire, and should be considered as only the first steps in a series of bigger initiatives, which must follow.

## E. The role of the United Nations system: a review

379. The United Nations, along with its specialized and associated agencies, has been playing an important role in stimulating international co-operation and in helping to promote the utilization of space technology by all countries. A large number of United Nations divisions, agencies, etc. have been involved in this and their efforts have ranged from creating awareness about space technology to themselves undertaking or setting up agencies for operational activities in space applications. Here, no attempt is made to describe the activities of all the agencies or even to identify all of them. The focus is on the overall-impact of their collective efforts and recommendations to increase this.

### 1. Committee on the Peaceful Uses of Outer Space

380. A key role with regard to United Nations activities in matters concerning outer space is played by COPUOS. An ad hoc committee on outer space established by the General Assembly in 1958 was replaced by COPUOS (established in 1959). In a resolution in 1961, the General Asembly decided that within the United Nations system COPUOS should provide a focal point for international co-operation in the peaceful exploration and use of outer space. The Committee, which has a membership of 53 countries, has the mandate to discuss the state-of-the-art and future developments in the peaceful uses of outer space, to review international co-operation in this area and to study practical and feasible means for giving effect to programmes which promote such co-operation. It was also requested to study the legal problems that might arise from the exploration and uses of outer space and to organize exchange and dissemination of information relating to space activities.

381. In undertaking these functions, the Committee is assisted by the two permanent sub-committees (Legal, and Scientific and Technical), and can draw on the experience of the specialized agencies and other bodies invited to participate in its work. On specific or technical matters, the Committee has, from time to time, established working groups to assist it.

382. The Committee has carried out several scientific, technical, economic and social studies relating to space communications, direct broadcasting, remote

sensing, navigation and the use of nuclear power sources in outer space. It has taken important steps to promote the systematic and orderly growth of space activities, particularly by drafting and concluding five international treaties covering a number of vital issues (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; the Convention on International Liability for Damage Caused by Space Objects; Convention on Registration of Objects Launched into Outer Space; and the Agreement Governing the Activities of States on the Moon and other Celestial Bodies). Discussions on a number of other issues are continuing. These are legal aspects of remote sensing, direct international television broadcasting via satellite, use of nuclear power sources in space, and definition and delimitation of space, including matters relating to GSO. It has also given the impetus to an international education and training programme by establishing and guiding the United Nations Programme on Space Applications.

### 2. Outer Space Affairs Division

383. The Committee, its working groups and its Scientific and Technical Sub-Committee are serviced by the Outer Space Affairs Division in the Department of Political and Security Council Affairs of the United Nations Secretariat. The Division has responsibility for implementing decisions of the Committee and its subsidiary bodies related to the promotion of international co-operation and peaceful uses of outer space. It provides expert advice - on request - to Member States, carries out studies requested by COPUOS, disseminates information on space events to Member States through a monthly bulletin and maintains the international registry for objects launched into space. It services the Sub-Committee on Outer Space Activities of the Administrative Committee on Co-ordination. It also oversees the Programme on Space Applications, which was initiated in 1969, following the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. This programme and the Expert on Space Applications have played an important part in increasing the awareness of all countries about the benefits to be derived from the applications of space technology.

384. The Programme on Space Applications organizes, sponsors and conducts a variety of seminars, panels and workshops in fields of practical applications of space technology, particularly in space communications, space meteorology and remote sensing as applied in various disciplines including cartography, agriculture, forestry, geology, oceanography and other related earth sciences. As interest is expressed, various seminars/panels/workshops relating to specific problems or regions are organized in co-operation with concerned Member States and/or specialized agencies as a complement to activities undertaken by them. Over 30 such international seminars/panels/workshops (with some 1,100 participants from developing countries) have been held in various parts of the world, including developing countries which have undertaken programmes aimed at integrating space technology in their economic and social development. Other organs of the United Nations have made important contributions in these, as have non-governmental scientific organizations.

385. Under the Programme on Space Applications, the United Nations can, upon request by Member States or organizations within the United Nations system, provide within the limits of resources available, technical advisory services in the applications of space technology for development. The Programme has also co-ordinated several surveys on the needs of developing countries in the utilization of space technology for development, including visiting missions to countries in the Middle East and Africa. The Programme is also responsible for the administration of fellowships for advanced training in fields of space science and tecnology which are offered by interested Member States to individuals of developing countries.

### 3. Office of Legal Affairs

386. The Office of Legal Affairs in the United Nations Secretariat provides secretariat assistance and services the Legal Sub-Committee of COPUOS. On request by the Legal Sub-Committee, the Office of Legal Affairs prepares reports and studies on items under consideration by the Legal Sub-Committee.

### 4. Natural Resources and Energy Division

387. Within the Depatment of Technical Co-operation for Development, the Natural Resources and Energy Division is responsible for a broad programme of activities in the fields of cartography (surveying and mapping), energy, geology and mining, and water resources. The programme consists of two basic types of activities: operational or field projects for technical assistance, and non-operational projects including studies, seminars and conferences. Both aspects of the programme focus on meeting the needs of developing countries.

388. Of primary interest to the Natural Resources and Energy Division is the use of remote sensing as a tool for resources exploration, particularly as it can benefit the developing countries. In this connexion, the Remote Sensing Unit within the Division co-operates with those sectors of the United Nations and its agencies responsible for project execution, particularly in the field of natural resources development. This co-operation involves such activities as providing substantive assistance in the design and evaluation of space-related remote sensing projects, facilitating access to satellite remote sensing data, advising on the feasibility of particular remote sensing applications and providing support for remote sensing centres being established in various regions. In a non-operational context, the Division participates, together with other United Nations bodies, in sponsoring various seminars and training programmes and in providing fellowships to individuals from developing countries.

### 5. Office of the United Nations Disaster Relief Co-Ordinator (UNDRO)

389. UNDRO was established in 1972 to mobilize, direct and co-ordinate relief activities of the United Nations system in response to requests from countries to promote the study, prevention, control and prediction of natural disasters, and to advise on pre-disaster planning.

390. UNDRO activities focus on the development and use of data-gathering techniques for forecasting and predicting natural phenomena likely to cause disasters. It is studying the use of satellites for obtaining imagery for post-disaster relief co-ordination purposes and co-operates in sponsoring training programmes in the use of remote sensing for disaster forecasting and in the dissemination of information on relevant technological developments. Further details about UNDRO are to be found in Conference background paper A/CONF.101/BP/IGO/5.

### 6. United Nations Environment Programme (UNEP)

391. UNEP, created in 1972, has responsibilities which include co-ordinating environmental programmes within the United Nations system, reviewing their implementation and assessing their effectiveness. It also advises, as appropriate, intergovernmental bodies of the United Nations system on the formulation and implementation of environmental programmes.

392. Of primary interest to UNEP is the use of satellite remote sensing for the systematic collection of environmental data. UNEP is responsible for co-ordinating the Global Environment Monitoring Systems (GEMS), a major and long-term programme that includes environmental survey activities of Member States, the specialized agencies and UNEP. The purpose of GEMS is to ensure the systematic collection of quantitative data for determining the state of the environment and for monitoring changes in critical environmental variables. As part of GEMS a variety of projects are being executed in co-operation with FAO in such fields as the control of desertification, rangeland development and management, and the assessment of earth resources including forests and soils.

393. It seems certain that remote sensing techniques will play an increasingly important part in the activities of UNEP related to agriculture and land-use practices, climate monitoring, global ozone monitoring, etc. (see also chap. II H, para. 300).

### 7. United Nations Development Programme (UNDP)

394. UNDP is actively involved in developmental activities almost all over the world and has funded many projects in the space field. The majority of UNDP-funded projects relating to space science and technology are in the three fields of natural resources surveys, technology transfer and planning. Activities of special interest to UNDP include those in communications, weather and pest forecasting, radio and television broadcasting for development, and a variety of resource surveys, including crops, forestry, minerals, and soil and water. Among the projects currently being carried on in conjunction with the responsible specialized United Nations agencies are: development of an experimental satellite communication earth station and the organization of relevant on-site training courses, establishment of a regional meteorological centre, preparation of a variety of feasibility studies, development of a telecommunications system, regional integration of telecommunication networks, establishment, together with FAO, of a training programme on the uses of remote sensing in crop prediction, and a UNDP/WMO project for a hydrometeorological survey.

## 8. International Telecommunication Union (ITU)

395. The countries members of ITU and the ITU permanent organs progressively have played a major and important role in the systematic planning, management and regulation of space communication activities through allocation, co-ordination, notification and registration of radio frequencies and positions on the GSO for the various radio communicatiion services using space tecniques. The co-ordinating and registering mechanisms for space radio communication are essentially those used over many years for conventional terrestrial radio communication. The countries members, having included the necessary provisions in the international treaty (International Telecommunication Convention and the Radio Regulations annexed thereto), entrusted the International Frequency Registration Board from 1963 with the added responsibility for the registration of technical basic characteristics of each space network station co-ordinated and notified under the Radio Regulations including the geostationary satellite orbital information, and, in 1973, included among the purposes of the Union specified in the International Telecommunication Convention "to effect, in the same conditions and for the same purpose, an orderly recording of the positions assigned by countries to geostationary satellites". A new article on "Rational use of the radio frequency spectrum and of the geostationary satellite orbit" has been added. The International Radio Consultative Committee (CCIR) and the International Telegraph and Telephone Consultative Committee (CCITT) carry out various studies which result in important recommendations.

396. ITU organizes frequent World Administrative Radio Conferences (WARCs) to review and, where necessary, revise the pertinent portions of the ITU Radio Regulations, inter alia (1) to take into account technical progress in the various fields and new requirements in radio communication services submitted by all countries in the light of Article 33 of the International Telecommunication Convention which provides for equitable access to, and efficient and economical use of the geostationary satellite orbit and the radio frequency spectrum by all countries, and (2) to provide the basis for countries in a position to do so to develop techniques designed to improve the utilization of the radio frequency spectrum and the geostationary satellite orbit with a view to increasing the total radio communication facilities available to the world community. As early as 1959, at a WARC in Geneva, frequency allocations were made for the space research service; and in 1963, another world conference at Geneva was held at which frequency bands were allocated for the various radio communication services which were to use space techniques; and obligatory procedures, between countries and through IFRB, for the co-ordination, notification and registration of the use of radio frequencies and the geostationary satellite orbit were developed and adopted. These allocations and procedures were progressively reviewed, developed and revised in world conferences at Geneva in 1971, 1977 and 1979. In 1985, another WARC is scheduled with the objective "to guarantee in practice for all countries equitable access to the geostationary satellite orbit and the frequency bands allocated to space radio communication services" (WARC, 1979, Resolution No. 3), as part of a programme of world and regional administrative radio conferences to be held up to 1988.

'. Obviously, the whole regime of frequency allocation and co-ordination is dependent on co-operation for mutual protection and benefit. As the demand on resources like GSO and the radio frequency spectrum grows, and as the complexity of services increases, there is greater need for co-operation. All countries should therefore continue to work together in order to maximize the benefit to each.

398. Member States of ITU - themselves and through IFRB, CCIR, CCITT and the Technical Co-operation Department of the General Secretariat - also provide technical assistance in telecommunications. Short-term technical assistance is funded by UNDP, UNESCO and voluntary contributions by Governments. Such assistance includes frequency management and technical seminars, special preconference seminars, experts, fellowships, training in developed countries and provision of equipment. ITU also assists in the setting up of training centres - for example, in India, Malaysia, Angola, Malawi, Honduras, Ecuador - at which training is given to nationals both from the host country and from other countries in the region.

## 9. World Meteorological Organization (WMO)

399. The advent of artificial satellites has had a considerable impact on the activities of WMO and has resulted in very great benefits to national meteorological services throughout the world. The effect on WMO has in fact been so important that practically all the constituent bodies of the organization are engaged directly or indirectly in outer space activities. In this, it works in close co-operation with FAO and other concerned agencies.

400. The role of satellites has considerably increased not only in obtaining various kinds of observational data, in particular quantitative data, but also in providing a capacity for collection and distribution of information in support of various WMO programmes. Indeed, it is now generally recognized that satellites are indispensable for the success of WWW, GARP, the Tropical Cyclone Programme, the Integrated Global Ocean Stations Sytem (IGOSS) - jointly with the Inter-governmental Oceanographic Commission (IOC) - the Hydrology and Water Resources Programme, agro-meteorological programmes, and other WMO programmes.

401. WMO has also undertaken extensive education and training programmes for experts from developing countries in order to train them in the use of meteorological satellite data.

## 10. Food and Agriculture Organization of the United Nations (FAO)

402. FAO has been using satellite imagery as an aid to its activities since 1969. It carried out experimental studies, using satellite imagery, in some countries in 1972-1973 and, in recognition of the great utility of space techniques to its work, FAO set up a remote sensing unit in 1976. In 1980, this was upgraded to a remote sensing centre, on the basis of the recommendation by COPUOS to set up two such centres in the United Nations system (the second centre is in the Natural Resources and Energy Division of the Department of Technical Co-operation for Development - see paras. 387, 388). The FAO Remote

Sensing Centre has the responsibility within the United Nations system for renewable resources, and undertakes the following functions: advisory services and technical assistance to Member States, training courses for developing countries, support to the FAO field programmes, co-ordination of remote sensing activities at FAO headquaters and in the field, and serving as the liaison point between FAO and other major organizations concerned with space applications.

403. The Remote Sensing Centre acts as the organization's focal point for space activities. It provides technical backstopping to a large number of field projects whose work involves the application of remote sensing and develops projects where such applications predominate. It is closely involved in the formulation and execution of regular programme activities with a remote sensing component, including a range of activities carried out in collaboration with other United Nations agencies. It has developed facilities at FAO headquarters, among which are a global index of satellite imagery, including the LANDSAT 16 mm browse file, a library of such imagery for developing countries and of remote sensing literature, and a laboratory for the interpretation and analysis of aerial photographs and satellite imagery.

404. FAO organizes, sponsors and conducts a range of educational activities and training seminars, workshops and panels in fields of practical application of space technology in developing countries and by using the facilities of its Remote Sensing Centre for renewable resources in Rome. Much of its work is devoted to assisting Member States in establishing their own national centres and national infrastructures and advising and assisting developing countries and other international organizations in relation to the applications of remote sensing and the development of programmes and facilities for this purpose. The Centre is assisting towards the international co-ordination of satellite and airborne data and the development of associated national data bases, and also represents FAO in a range of bodies within the United Nations system and in international scientific organizations concerned with remote sensing. A more detailed exposition of FAO activities in this field is to be found in the Conference background paper A/CONF.101/BP/IGO/6.

### 11. United Nations Educational, Scientific and Cultural Organization (UNESCO)

405. UNESCO is also involved in space technology applications, especially space communication. It has sent expert missions to various countries to study the feasibility of satellite communications and has acted as executing agency for UNDP-funded projects aimed at strengthening programme production capability for satellite broadcasting experiments. It has also been a forum for discussion of matters relating to satellite broadcasting, and in 1972 adopted a declaration of guiding principles on the use of satellite broadcasting. The International Programme for the Development of Communication (IPDC) of UNESCO, established in 1980, expects to reinforce the activities in this field. A symposium on regional and international mechanisms for the dissemination and exchange of information took place in Paris in Autumn 1981. As a result of the meeting, a mission was sent to INTELSAT in Washington to discuss the use of

satellite facilities by developing nations. A tentative agreement was reached on an experimental project for the use by third world broadcasts and the press of this satellite capability. This project was among those receiving some funding from the IPDC meeting in Acapulco, 18 - 25 January.

406. The interests of UNESCO in remote sensing of the earth are mainly connected with its programmes concerning monitoring of the natural environment and its resources. The applications of space remote sensing and conventional (airborne) remote sensing techniques are being promoted and conducted in operational projects within the framework of the Man and the Biosphere Programmes (MAB), the International Geological Correlation Programme (IGCP), the International Hydrological Programme (IHP), the Interregional Project on research and training leading to the Integrated Management of Coastal Systems, as well as in several projects undertaken by its Intergovernmental Oceanographic Commission (IOC). UNESCO has been sponsoring a number of regular post-graduate training courses in this general field and has promoted a series of activities on remote sensing applications in the form of symposia, seminars, workshops and *ad hoc* training courses, in collaboration with national and international institutions.

### 12. Inter-Governmental Maritime Consultative Organization (IMCO)

407. IMCO has, especially since 1966, taken a considerable interest in the development of space technology for maritime purposes. The culmination of this has been the creation of INMARSAT (see para. 338). IMCO is now developing requirements of a future global maritime distress and safety system which is expected to be implemented by 1990. This will make use of low-power distress transmitters (on ships and also on ships' survival craft) operating through geostationary and polar orbiting satellites which will also be used for shore-to-ship long-range alerting. This system will be developed in close co-operation with ITU and INMARSAT. IMCO is also developing an international plan for the provision of maritime search and rescue services which will include procedures for routing distress messages to appropriate rescue co-ordination centres. Further details on IMCO activities are to be found in Conference background paper A/CONF.101/BP/IGO/3.

### 13. International Civil Aviation Organization (ICAO)

408. ICAO has as an important objective: the economic application of satellite services to international civil aviation. It has accordingly been engaged in the definition of appropriate operational requirements and the best means of satisfying those requirements. The aeronautical fixed service, which interconnects the ground infrastructure responsible for the safety of flight, already utilizes satellite communication links where available and feasible. The aeronautical mobile service, which provides communications between aircraft in flight and the ground communication network, could benefit for the first time from the provision by satellites of instant, static-free communication between pilots and controllers over all parts of the earth's surface. The aeronautical radio navigation service could benefit from the application of satellites to provide radio-determination of aircraft position during flight over any part of

the earth's surface, utilizing a variety of navigation techniques.In each of the two latter applications, the desirability of providing service over the polar regions adds to the complexity of possible solutions and extends considerably the range of technical problems which must be considered by ICAO.

409. ICAO is also concerned with other aspects of space, including use of satellites for search and rescue services, the obtaining and exchanging of aeronautical meteorlogical data, the definition of outer space, transport to and from outer space, problems related to safety, including the hazard caused to civil aircraft in flight by space debris returning to earth, etc.

410. The ICAO Assembly has resolved that ICAO be responsible for stating the position of international civil aviation on all related outer space matters. The resolution also requested the Secretary-General of ICAO to "ensure that the international civil aviation position and requirements are made known to all organizations dealing with relevant space activities and to continue to arrange for the organization to be represented at appropriate conferences and meetings connected with or affecting the particular interests of international civil aviation in this field". The recent session of the ICAO Assembly decided that the Council of ICAO should continue to monitor the work of COPUOS and should request the ICAO Legal Committee, if and when necessary, to study with due priority the implications for the Chicago Convention, Annexes and other international air law instruments, of important decisions taken within the framework of the United Nations and other international bodies. Further details on ICAO activities are to be found in the Conference background paper A/CONF.101/BP/IGO/1.

### 14. World Bank

411. The World Bank has been involved mainly in the funding of telecommunications earth stations for domestic and international traffic and is involved in studying the feasibility of using satellites for education. The World Bank also has an active interest in remote sensing and makes extensive use of satellite imagery, especially for the identification, preparation and monitoring of agricultural, irrigation and transportation projects. It provides assistance to many countries in the field of remote sensing, particularly for applications in the area of renewable resources.

### 15. Other agencies

412. Other specialized agencies, divisions, etc. within the United Nations system also have an active interest in space technology and its applications. A summary of this, and more details about the work of the agencies etc. mentioned above, are to be found in the Conference background papers (see A/CONF.101/BP 11 and A/CONF.101/BP/IGO/1, 3, 5, 6, 7 and 8).

### 16. Co-operation and co-ordination

413. Acting upon recommendations of COPUOS, the General Assembly has called upon organizations concerned to consider undertaking space science and

technology programmes jointly or in close consultation or co-operation with one another. Such recommendations have included, for instance, those calling for co-operation in the implementation of WWW in the 1960s as well as in the subsequent programmes for the strengthening of meteorological services and research and for the expansion of training and educational opportunities in these fields, and those calling for co-operation in technical and other assistance to help meet communications needs of Member States and for the effective development of domestic communication.

414. Co-ordination of the space activities of the United Nations system is carried out by an ad-hoc Sub-Committee on Outer Space Activities established under the Administrative Committee on Co-ordination (ACC). This inter-agency sub-committee, whose meetings are attended by representatives of the organizations concerned in the United Nations system, meets annually to work out joint programmes and co-ordinate their related activities. The results of its work are reported annually to COPUOS and its Scientific and Technical Sub-Committee.

## F. The role of the United Nations: an assessment and recommendations

415. As is obvious, space science and technology have developed over the last quarter of a century at a most dramatic rate. In recent years there has been an equally dramatic growth in the field of space applications, many of which have now reached an operational stage. Space technology clearly has important socio-economic implications, some of which are already visible; at the same time, its effects on all mankind - not merely on those who use it - could be substantial. All these considerations, which led to the convening of this Conference, and the initiatives which will result from it, call for an assessment of the role of the United Nations and for appropriate recommendations regarding its contribution to the process of enabling all States to benefit from space technology.

416. Regarding the financial implications of the recommendations made by this Conference, it is understood that the proposed new or expanded activities, including personnel costs, of the United Nations are to be funded mainly through voluntary contributions of States, either in money, or in kind. However, the decision itself to convene UNISPACE 82 demonstrates clearly that space science and technology are an area of increasing importance at the international level and should thus be given adequate priority within the United Nations. The Conference recommends therefore that the General Assembly through its competent organs rearrange priorities within the United Nations' next regular budget in such a way that the modest increase in personnel costs proposed below may be absorbed within the available resources.

417. From the foregoing paragraphs reviewing the role of various elements of the United Nations system and taking into account concerns and suggestions expressed by Member States in their national papers, in COPUOS and other fora, the Conference examined the following specific points with regard to the role of the United Nations:

(a) Strengthening the role of COPUOS as the only standing committee of the General Assembly for international co-operation in the peaceful uses of outer space in accordance with its mandate;

(b) Giving fresh impetus and reorientations where necessary to the United Nations Programme on Space Applications;

(c) Strengthening and expanding the role of the Outer Space Affairs Division so as to better enable it to fulfil its tasks in the implementation of the recommendations of the Conference;

(d) Finding appropriate ways and means to ensure smooth and prompt implementation of the Conference recommendations;

(e) Ensuring full co-ordination within the United Nations system with regard to space activities.

418. The following paragraphs briefly examine these and related issues and make specific recommendations.

419. [The increasing militarization of space is a matter that has caused great concern to Member States. While military and disarmament matters are dealt with in other fora of the United Nations, and issues regarding militarization of space have been referred by the General Assembly to the Committee on Disarmament, increasing militarization does directly impinge on peaceful uses of space and on the benefits that nations can derive from space. To this extent, and by the fact that the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies - which banned nuclear weapons or weapons of mass destruction in outer space - was initiated and formulated in COPUOS, such matters are within the legitimate concern of COPUOS also. It is therefore suggested that COPUOS should examine and refer for consideration of the General Assembly how best it can ensure that outer space is used for solely peaceful purposes.]

420. COPUOS, which is responsible to the General Assembly, will remain the only intergovernmental body exclusively concerned with all aspects of peaceful uses of outer space and all related activities in the United Nations system. It should include on its agenda regular items pertaining to the follow-up of the Conference recommendations. COPUOS continues to be assisted by its two sub-committees, the Legal and the Scientific and Technical Sub-Committees. The Conference recommends that COPUOS should continue consideration of the best and most suitable working methods for the Committee and its two sub-committees.

421. Earlier sections of this report have recommended the conduct of a number of studies. While some of these studies fall into the prerogatives of Member States and regional organizations and require their direct initiative, many of the proposed studies will have to be conducted within the United Nations in association, where appropriate, with concerned specialized agencies and intergovernmental or non-governmental organizations. The studies proposed vary in scope and importance as well as in qualitative aspects. It is therefore

recommended that the primary responsibility for arranging and/or conducting those studies remain with COPUOS, in accordance with the order of priorities established by COPUOS. The Committee will also have to decide on the most appropriate methods of conducting these studies, be it through the establishment of working groups of governmental experts within the framework of the Committee and its sub-committees, through ad hoc task forces or through hired consultants.

422. As noted earlier, the United Nations Programme on Space Applications plays an important role in promoting awareness about space technology and its benefits. It has performed this task to the satisfaction of Member States despite the very limited resources at its disposal. However, as needs grow and more and more countries become interested in the applications and use of space technology, it may not be able to meet satisfactorily the demands made on it. Developing countries have pointed out the need for not only more seminars, training courses, etc. but also for longer periods of exposure, greater depths of training and adequate financing for these activities. COPUOS has discussed for several years the need to expand the Programme on Space Applications and, at its request, the Expert on Space Applications has prepared a plan for such an expansion (see A/CONF.101/BP/11/Add.2).

423. At the same time, the Programme on Space Applications should move forward and play a more concrete role in helping requesting countries to select, execute and benefit from appropriate applications. Therefore, the Programme should be directed towards the following objectives:

(a) Promotion of greater exchange of actual experiences with specific applications;

(b) Promotion of greater co-operation in space science and technology among developing countries as well as between developed and developing countries;

(c) Development of a fellowship programme for in-depth training of space technologists and applications specialists, with the help of Member States;

(d) Organization of regular seminars on advanced space applications and new system developments for managers and leaders of space application and technology development activities as well as short duration seminars for users in specific applications;

(e) Stimulation of the growth of indigenous nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries with the co-operation of other United Nations agencies and/or Member States;

(f) Dissemination - through panel meetings, seminars, etc. - of information on new and advanced applications, with emphasis on their relevance and implications for developing countries;

(g) Provision or arrangement for provision of technical advisory services on space applications projects, upon request by Member States.

The Programme should continue to make full use of the expertise available in other organs of the United Nations system, and should be implemented in close co-operation and co-ordination with the concerned specialized agencies/departments of the United Nations system.

424. Apart from the Programme on Space Applications, being executed through the Outer Space Affairs Division, a number of other units of the United Nations system are involved in operational activities, training, etc. The Conference recommends that these activities be continued and strengthened as appropriate, but places special emphasis on the imperative need to avoid duplication of programmes and to achieve full co-ordination in this field (specific recommendations have been covered in chapter II).

425. As mentioned in chapter II, paragraphs 203 and 211, the need and the desirability of setting up an international space information service has been emphasized by many countries. The Conference therefore recommends that this international space information service should be established, initially consisting of a directory of information about sources of information and data services, so that Member States, upon request, could be directed through the service to accessible data banks and information sources. At a later stage, COPUOS could evaluate its performance and examine the need and possibilities of expanding the service, bearing in mind the financial implications of such a step.

426. The expanded role of the Division, the new orientation of the Programme on Space Applications and the setting up of an international space information service will require some augmentation of technical personnel, though a nucleus does exist. Closer and more active co-ordination of space activities is needed, especially in light of their growing importance and magnitude and in order to ensure the best possible cost-efficiency. In addition to servicing COPUOS, the tasks to be carried out by the Division will thus considerably increase.

427. While suggestions have been made for the creation of a new international agency for space, this does not seem to be essential at this time. Instead, one possibility could be to consider an integration of the activities mentioned above into a Centre for Outer Space, which would consist of the Outer Space Affairs Division of the Department of Political and Security Council Affairs with enlarged responsibilities. Alternatively, the proposed integration and expansion could take place within the existing Outer Space Affairs Division. In either case, the enlarged responsibilities would include the following:

(a) Present task of the Outer Space Affairs Division;

(b) Servicing COPUOS in the implementation of the approved Conference recommendations, with special regard to the proposed studies;

(c) Conduct of studies if so requested by COPUOS;

(d) Implementing the reoriented and expanded Programme on Space Applications;

(e) Organizing and operating the international space information Service.

428. Since this is basically an intensification of present functions of the Division, the activities of specialized agencies and other United Nations organs will not be infringed upon or duplicated. Indeed, the Conference stresses the need to avoid duplication of efforts and to observe the best possible cost-efficiency in the execution of programmes. This goal could be achieved by establishing or expanding close linkages between all United Nations bodies engaging in space or space-related activities, such as, for instance, the United Nations Centre for Science and Technology and UNDP. Also, the ad hoc Sub-Committee on Outer Space Activities of the Administrative Committee on Co-ordination should continue to meet annually. It should discuss ways of ensuring closer co-ordination between the various agencies concerned and should also examine the feasibility of using each other's expertise more fully through joint co-operative programmes. All space-related programmes of each of the agencies should be discussed and co-ordinated at this forum before finalization.

429. The proposed Centre for Outer Space or the Outer Space Affairs Division with enlarged responsibilities should work in close co-operation with the various technical agencies in the United Nations system - ITU, WMO, FAO (Remote Sensing Centre), UNESCO and the Department of Technical Co-operation for Development (Natural Resources and Energy Division), in particular - as well as with funding agencies like the World Bank and UNDP, so that proper co-ordination of projects is ensured within the United Nations system.

430. The basic considerations of the Conference with regard to the aspect of financing its recommendations, are set out in paragraph 416 above. In addition, however, the Conference recommends that its approved proposals be forwarded to the funding agencies and bodies with established operational activities, so that they may be taken into account in the planning and setting up of programmes.

## Annex I

## INDEX TO CONCLUSIONS AND RECOMMENDATIONS

1. This annex lists the main conclusions and recommendations of the Conference, as contained in chapters I, II and III of this report and is prepared solely for the guidance and easy reference of Conference participants. There is no attempt to exhaustively list here all the suggestions etc. which are covered in earlier parts of this report; instead, only the major conclusions and recommendations are presented, enumerated according to the three major topics of the agenda (covered in chapters I, II and III respectively), and categorized separately on the basis of whom they are addressed to. The rationale, justification and explanation for each of the recommendations are provided in the text of the particular chapter, and are not repeated here. However, reference is given to the specific paragraph(s) from which the recommendation has been drawn. Clearly, this annex is not meant to stand independently; it is to be read together with the rest of the report.

2. The wording of the conclusions and recommendations is identical to that used in the respective chapters, except as necessary for proper contextual understanding. For convenience, the listing is in sequential order and not necessarily in order of priority. Thus, this annex is only intended as a guide or key to the conclusions and recommendations.

### A. State of space science and technology

3. Space science has made astounding progress since the dawn of the space era which, by allowing us to see the universe from outside the haze and distortions of our atmosphere, has literally opened new windows (of the electromagnetic spectrum) on the cosmos and led to amazing new discoveries. Astronomy - including radio astronomy - and planetary exploration have given us a better understanding of the outside world and also of our own planet. Space science and space scientists have provided the cutting edge of developments in space technology; at the same time, it is the tremendous advances in space technology that have spurred on work in space science. The two have been in a truly synergetic relationship and rapid advances in one or both depend upon and stimulate advances in the other.

4. Space science and technology have already provided many practical benefits and an increase in knowledge. The years ahead hold promise of even greater and possibly more revolutionary benefits in fields ranging from astronomy, cosmology, materials sciences and space biology to large structures in space, economical space transportation systems and new technologies for communications, meteorology, remote sensing and geodesy. The recommmendations that follow aim at realising this potential in a way that would benefit all mankind.

## 1. Conclusions and recommendations addressed to Member States

5. Space science should continue to have a high priority; in fact, in view of its promising future, it is desirable that support be substantially increased (para.42).

6. It is desirable that co-operation aimed at launching experimental payloads and crews from one country on spacecraft of another country should continue and be further encouraged. Major space observatories to be set up in the future should also be open to scientists and experimenters from all countries (para. 43).

7. The encouragement of space science and space astronomy in universities and institutions of developing countries could provide an important stimulus and strong support to the development and practical applications of space technology (para. 44).

8. It is essential that the results of experimentation in the field of materials sciences continue to be widely disseminated and readily available to scientists all over the world. It is desirable that the benefits of production in space of new materials be made available on reasonable terms to all nations and all mankind (para. 52; see also paras.306 and 307).

9. It is desirable that opportunities to use facilities in space for biological studies continue to be made available to scientists of all countries in a co-operative and co-ordinated manner (para.56).

10. It is desirable that experimental research in the microgravity environment be supported and carried out in a co-operative and co-ordinated manner in view of its long-term implications and its interest to humanity as a whole (para. 59).

11. The development of electronically interconnected "satellite clusters" should be encouraged. The expected impact of large platforms on GSO must be thoroughly studied in order to avoid any unnecessary congestion in the GSO (para. 70).

12. International organizations which operate communications satellites should make them available at minimal or no cost during disaster operations. An appropriate body of the United Nations system should be mandated to govern the over-all operations of the disaster operations communications system (para. 74).

13. Development of technologies and techniques for monitoring pollution and changes in atmospheric constituents, identifying pollutants, and for observations over oceans should be continued and encouraged (paras. 81, 82 and 83).

14. Development of meteorological systems that combine frequent observations with the capability for selective high-resolution observations and transmit data at low bit rates should be encouraged (para. 84).

15. The use of rockets for hailstorm control - as demonstrated in the USSR and China, for example - should be studied for other countries also (para. 86).

16. It is desirable that co-operation in meteorology - exemplified by co-ordination of efforts, the free availability of data from meteorlogical satellites through decentralized, direct reception and rapid world-wide data exchange - be not only continued, but further intensified (para. 88).

17. It is important that operators of remote sensing satellites should give definite indications regarding continuity and unrestricted availability of data at reasonable prices, so that countries can continue to invest in ground equipment or devise alternative means of obtaining the data (paras. 90 and 94). Also, when systems become operational, a number of users have expressed the need to institute arrangements to enable them to have continued access to data at reasonable costs (para. 96).

18. Space photography is a low-cost approach with respect to data analysis and therefore is particularly attractive for developing countries which cannot afford large investments in ground hardware. A great deal can also be done through simple, inexpensive equipment and appropriate techniques - e.g., colour composites, diazo prints, simple overlay and projection equipment, etc. (paras. 101 and 102).

19. Ground truth, data processing and analysis of remote sensing data need greater emphasis and it is desirable that countries devote special effort to work in these fields (para. 103).

20. The low investment on ground equipment and the high pay-offs in terms of new information make satellite geodesy and navigation attractive and suitable for most countries (para. 107).

21. It is desirable that wider deployment of both fixed and mobile high-performance laser ranging stations take place, so that internationally co-ordinated measuring campaigns can help develop a better scientific understanding of the earth and its dynamic features (para. 111).

22. Space-based laser-ranging equipment might be useful and cost-effective for certain purposes and its development deserves to be encouraged (para. 112).

23. It is desirable that the computation techniques, equipment and the necessary information for navigation/position-location using satellites be widely disseminated (para. 117). It is also desirable that world-wide access be provided to satellite navigation systems such as the United States Global Positioning System (para. 123; see also paras. 120-122).

24. It is desirable that launching services should be provided through bilateral or multilateral arrangements, on equitable terms, to all countries wishing to use them for peaceful purposes; also, the development of more economical space transportation systems should be encouraged in every possible way (para. 133).

### 2. Conclusions and recommendations addressed to international agencies/bodies

25. All work aimed at reductions in the cost of the ground equipment for satellite telecommunications and broadcasting is worthy of encouragement and support by all countries and international organizations (para. 63).

26. It is desirable that ITU continue to study the optimum allocation of bands for various services and the criteria for sharing, with a view to adopting appropriate changes at future World Administrative Radio Conferences (para. 66). In this regard, careful studies of various trade-offs are needed to arrive at an optimum solution (para. 67).

27. WMO should be encouraged to continue its examination of the feasibility of setting up regional or international centres for meteorological data reception and analysis (para. 87).

28. The long-term consequences of the increasing number of launchings should be studied; if there are harmful consequences, corrective measures should be taken (para. 133; see also para. 294).

29. Studies should be made of the implications for international co-operation of the new concepts of large-scale space systems (para. 142).

## B. Applications of space science and technology

30. Even as space science and technology made rapid advances, the applications of space technology to a wide variety of fields grew even more rapidly. Few technologies have seen as rapid a transition from proof-of-concept to routine operation. Today, space communication, satellite broadcasting, satellite navigation and space meteorology are used routinely in scores of countries around the world. Satellite remote sensing, though not yet formally operational, is almost as widely used and a range of new applications are beginning to open up. It is important that all countries have access to benefits from these, even as steps are taken to expand them. The recommendations that follow aim to do this.

### 1. Conclusions and recommendations addressed to Member States

31. It is desirable that developing countries examine the importance of communication (especially to and from rural areas) as an integral element of development (para.146) and undertake studies to determine the best approach for their communication needs (para.147).

32. Countries planning to use satellite communication systems would be well-advised to pay special attention to equipment interfaces, appropriate modems, organizational co-ordination, etc. (para.148).

33. [It seems desirable that developed countries shift their satellite communication systems to a different frequency band (e.g. 11/14 GHz), leaving

the 4/6 GHz band basically for use by developing countries. They should also be encouraged to shift their high-density and trans-oceanic traffic to submarine cable or fibre-optic systems, thereby decreasing the pressure on the RF spectrum and on the GSO] (para. 150).

34. Countries planning satellite-based land-mobile communication systems should be encouraged to look at the feasibility of using these systems for rural communication in developing countries (para. 153).

35. For high data-rate remote sensing satellites, central or regional data reception and processing facilities might be considered, possibly in conjunction with a system of distribution of processed data to simple, low-cost user terminals. At the same time, the development of "user friendly" satellites that can work with simple, inexpensive "user terminals" needs to be encouraged (para. 166).

36. It is necessary to ensure continuity of the service provided at present by the world-wide network of meteorological satellites through WMO, because many countries have become dependent upon this system (para. 174).

37. Each country should carry out studies regarding costs and benefits before deciding upon the adoption of a particular application. It should take account of not only economic aspects, but also technical, environmental and social effects that may result from the use of space technology (para. 189). Decisions to use space technology should be based on a proper "needs-conditions-alternatives" assessment and, if possible, also be based on the results of a pilot project (para. 195).

38. All possibilities for mutually beneficial co-operation betwen different countries by undertaking complementary efforts should be fully exploited (para. 191).

39. Countries which desire to engage in the manufacture of various space hardware should seek the advice of competent agencies concerning problems of transferring technology from the laboratory to industry and from country to country (para. 200).

40. Existing nuclei of experts need to be identified and organized by developing countries, and the necessary institutions and conditions created for expanding them rapidly (para. 212).

41. Countries planning to use space technology need to pay special attention to the organizational frameworks. They should organize and set up inter-agency co-ordination mechanisms appropriate to their situation and needs (para. 214).

42. There is a strong case for encouraging indigenous fabrication to the maximum extent possible (para. 221; see also para. 219). If equipment has to be imported, developing countries would be well advised to first look for appropriate equipment from other developing countries. Alternatively, they may have to adapt off-the-shelf developed-country equipment (para. 220).

43. Developed countries should continue to provide use of their spacecraft for pilot/experimental purposes, on equitable terms, wherever feasible (para. 223).

44. Countries should examine and modify as necessary their education system and curricula to place greater emphasis on science and technology. At post-graduate level, interdisciplinary work on areas connected with space technology and its applications must be encouraged (para. 237).

45. Countries should not place undue restrictions on the sale of components, sub-systems or systems required for space applications (para. 242).

46. It is essential that developing countries organize and encourage indigenous development of capabilities for development of space technology. Developed countries should consider providing all possible help for this (para. 243).

47. Developing countries should encourage and fully develop their existing technological capabilities and take planned measures to decrease their dependence on foreign expertise. Developed countries should not always provide equipment in complete-system or "package" form, but should be willing to provide individual elements. Developing countries should strive to import such separate elements instead of integrated systems (para. 244).

48. It is suggested that countries examine the feasibility of using DBS to aid the spread of education and explore the possibility of sharing the space segment (para. 249).

49. It is desirable that strong encouragement, including financial and technical assistance, be given to efforts aimed at developing low-cost community receivers for DBS and low-cost, preferably renewable, power sources to operate the system in unelectrified locations (para. 251).

50. It is suggested that efforts at developing more powerful broadcasting satellites, within the constraints of international regulations, be pursued and encouraged (para. 252).

51. Countries which plan to set up a DBS system would be well advised to devote effort and attention to "software" aspects (para. 255).

52. Efforts should be devoted to the development of CCT and film products of remote sensing data which are platform and sensor independent in a cartographic projection (para. 270).

53. Remote sensing system operators might keep in mind the importance of continuity in data availability in a form compatible with present systems (para. 272).

54. While compatibility and complementarity between different systems is generally desirable, certain considerations and restraints need to be borne in mind (para. 275).

55. Efficiency of GSO and RF spectrum usage is important, and any plan and/or other arrangement that is formulated must encourage greater efficiency. However, efficiency should not be a barrier to attempts at technological self-reliance. The positive efforts of the developed countries to increase efficiency should be supported and continued (para. 281).

56. Any planning method and/or arrangement that is evolved for the GSO-RF spectrum should recognise and accommodate the future needs of developing countries and should not result in unnecessarily hastening their plans to the detriment of their financial and self-reliance interests (para. 282).

57. [Newer technologies that lead to better utilization of the GSO and RF spectrum should be adopted insofar as possible by all countries and international organizations] (para. 281; see also para. 150).

58. Countries should examine whether for their needs they could use a satellite in elliptical orbit rather than in GSO (para. 285).

59. Development efforts undertaken by technologically advanced nations aimed at evolving new techniques that contribute to more efficient use of GSO should be encouraged and continued (para. 287).

60. To minimize the possible future eventuality of a catastrophic collision between a "live" space object with a piece of space debris, the international community might, on the basis of more detailed studies, agree to appropriate measures such as designating "disposal" orbits, removing from orbit all inactive satellites, minimizing space debris or even organizing scavenging missions (para. 289).

61. It may now be time for countries to agree, as soon as possible, on the legal implications of remote sensing of the earth from space and on principles governing direct TV broadcasting via satellite (para. 310).

### 2. Conclusions and recommendations addressed to international agencies/bodies

62. Studies about the importance of communication (especially rural communication) as an element of development should be undertaken by appropriate United Nations agencies - especially ITU and UNESCO. Adequate funding for systems (national and regional) that aim to strengthen the communications infrastructure should be provided by funding institutions (para. 146).

63. The United Nations system should provide, or arrange to provide, to Member States assistance - on request - for studies related to communication (para. 147), maritime communication requirements (para. 155), and cost-benefit and impact analysis (para. 189); for choices of applications or systems (para. 190 and 212); for systems studies (para.215); for co-operative efforts by developing countries (para. 222); for DBS feasibility studies (para. 249); to develop appropriate system configurations for using space technology for education (para. 259).

64. [ITU should examine the feasibility of relaxing flux density limitations in certain geographical regions and/or in part of the 4 GHz and VHF/UHF bands for satellite-based rural communication] (para. 150).

65. The United Nations, in association with appropriate specialized agencies, should carry out a study on the feasibility of meeting rural communications needs (especially for non-instantaneous communication) through concepts such as low-orbit "travelling electronic postman" satellites (para. 151).

66. INMARSAT (with ITU and IMCO) should continue its efforts to simplify ship-borne communications terminals for use on small ships. It should examine necessary changes in the overall system design to enable greater usage by developing countries (para. 155; see also para. 73), and the possibility of meeting one-way communication and beacon transmission needs of small ships and boats (para. 156).

67. It is desirable that studies on an operational aeronautical communication system be continued by ICAO and INMARSAT (para. 157; see also para. 73).

68. The United Nations system should examine the implications and potentials of the new developments in communications technology, especially for the developing countries (para. 159).

69. The United Nations system and interested countries should study the remote sensing needs of developing countries and assess appropriate systems to meet them. It should also encourage dialogues between users/potential users and designers/producers of satellite systems to see how and to what extent user needs can be met (para. 171).

70. The current discussions in COPUOS on principles governing satellite remote sensing should be completed expeditiously (para. 172).

71. In view of the importance and humanitarian nature of search and rescue systems, it is desirable that the present co-operation be continued and efforts be made to evolve a world-wide operational satellite-based search and rescue system as soon as possible (para. 183).

72. The provision of experts should not be a mandatory part of any aid package provided by international agencies (para. 197).

73. It is recommended that existing international satellite data banks (including especially those in the Remote Sensing Centre of FAO and in DNRE/TCD in the United Nations) be strengthened and expanded. Other data banks at national and international levels should also provide access to data on a reasonable basis (para. 210).

74. An information centre that acts as a clearing house linking needs with sources should be set up in the United Nations (para. 211; see also paras. 203 and 427).

75. The United Nations should collect, collate and disseminate information on the co-ordination and organizational mechanisms devised by various countries who have had experience in space applications (para. 214).

76. International financial agencies should provide financial support, as appropriate, for demonstration projects undertaken by developing countries (para. 223).

77. All countries should continue to have free access to meteorlogical data and WMO should envisage to undertake a study concerning the possibility of setting up an international structure providing access to satellite meteorological data (para. 224).

78. A study should be undertaken to assess the need for and viability of a world-wide remote sensing system, keeping in mind that only the space segment need be internationally owned (para. 227).

79. The feasibility and desirability of specially designed systems for rural telecommunications (e.g., the ITU GLODOM proposal) should be examined (para. 230).

80. [The United Nations, in co-operation with concerned specialized agencies, should initiate a study on the feasibility of an international satellite navigation/geodesy system and work out the technical, financial and organisational details] (para. 231; see also paras. 184 and 186).

81. The United Nations should organize a fellowship programme for in-depth, long-term exposure of selected graduates or post-graduates to space technology or applications. On-the-job experience should be included and the training centres should, as far as possible, be in developing nations (para. 238: see also para. 212).

82. The United Nations should support the development of appropriate training centres at regional levels linked, whenever posible, to institutions implementing space programmes. Necessary funding should be made available through international financial institutions (para. 239).

83. The United Nations, in association, where appropriate, with concerned specialized agencies, should conduct regular three to five week "managerial" seminars for high-level personnel concerned with space applications and technology (para. 240).

84. The United Nations and international financing agencies should consider providing all possible help to developing countries in setting up indigenous centres for the absorption, adaptation and development of space technology (para. 243).

85. The United Nations and concerned specialized agencies should examine the feasibility of international or regional satellite system(s) for providing DBS services, including the cost-effectiveness of multi-mission platforms. Organi-

zations such as INTELSAT may choose to consider developing broadcasting satellite systems which could be used for educational purposes (para. 249).

86. [It is desirable that ITU study the feasibility of phasing out - in the long run - terrestrial services in some of these bands (0.7, 2.5 and 4 GHz) so that they can be assigned exclusively to satellite broadcasting and flux density limits relaxed] (para. 253).

87. The United Nations, in co-operation with appropriate specialized agencies (including especially UNESCO) should initiate a study on the educational opportunities that emerge from satellite and related telecommunications tecnologies (para. 258).

88. WMO should continue to actively promote international co-operation in space meteorology, encourage compatibility and complementarity between different systems and take all necessary steps to ensure continuity of data availability to all countries (para. 264).

89. ITU should examine the feasibility of incorporating in its future regulations a stipulation that each satellite owner is responsible for removing its satellites from GSO, when they are no longer in use (para. 283).

90. It is desirable that Member States, within the ITU, continue to evolve some criteria for the most equitable and efficient usage of GSO and the RF spectrum and to develop planning methods and/or arrangements that are based on the genuine needs, both present and future, identified by each country. [This should emphasize those uses which promote development, including education. It should also ensure equity, consider the needs of developing, tropical and far-northern countries, and take into account the special interest of the equatorial countries] (para. 284).

91. The feasibility and over-all advantages of using elliptical orbits for international communication merit re-examination (para. 285).

92. The United Nations - in paticular, UNEP - should encourage the continuation and expansion of on-going studies aimed at examining the effects of release of gases or materials in space, determining the effect of frequent rocket launches and evaluating the effects of using ion engines (para.294).

93. An integrated global ozone observing system should be created, under the aegis of WMO and UNEP (para. 300).

94. World-wide monitoring of the earth's environment and necessary remedial action should be co-ordinated by UNEP. All countries should promptly provide all relevant data required for such monitoring purposes to UNEP (para. 301).

95. The feasibility of undertaking a joint international effort with regard to SPS should be examined and - as a corollary - the means of sharing internationally the benefits that result (para. 305).

96. [International mechanisms might have to be formulated to ensure that benefits that may result from commercial materials-processing in space are available to all nations] (para. 306). With regard to the use of extra-terrestrial material for space processing, or for use on earth, note should be taken of the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (para. 307).

97. The United Nations should periodically organize studies to examine all the global implications - technical, social, economic, environmental and legal - of new space developments, especially for developing countries (para. 313).

## C. International co-operation and the role of the United Nations

98. Co-operation between nations on matters concerning space has a long and rather fruitful record. There are few fields of human endeavour where the need for co-operation is more essential and the pay-off greater. It is the recognition of this necessity and benefit that has led to such very successful examples of co-operation as the operational international satellite communication and satellite meteorology systems. The continuation of such co-operation, and its further expansion to other fields also, is of great importance, as is the need to foster greater co-operation between developing nations. The recommendations that follow seek to bring this about.

99. The United Nations system has played a key role in bringing about greater international co-operation. It has also been an important source of assistance and advice for developing nations. Now, as space technology moves increasingly into a phase of more extensive, routine applications, there is a need to see how the United Nations system can play a larger role in helping all countries derive greater benefits from space. The recommendations in this section seek to address this issue also.

### 1. Conclusions and recommendations addressed to Member States

100. More extensive co-operation, and more co-operative projects aimed at specific problems are necessary. Greater benefits from space can be derived by intensifying international co-operation and in this the tecnologically-advanced nations have a special responsibility (para. 358).

101. Developing countries - despite their widely varying levels of economic, scientific, technological and industrial development - recognize the similarity of their problems and the complementarity of their needs and resources. It is highly desirable that they get together and co-operate with each other, so as to collectively make the most of what they have (para.367).

102. Efforts should be made - both by the countries concerned and by international agencies - to encourage the flow of equipment made by developing countries to other developing countries (para. 368; see also para. 220).

103. Developing countries might find it to their mutual advantage to seek and provide expert assistance - when required - from and to each other (para. 369).

104. Developing countries should promote exchange of information and visits of scientists, technologists and decision-makers among themselves (para. 370).

105. Developing countries should take concrete steps to conceive, initiate and implement specific co-operative programmes among themselves on a regional, bilateral or multilateral basis (para. 375). Since the technical and economic advantages of jointly-owned systems are already obvious in many situations, the developing countries should, through an act of political will, take steps to implement such co-operative programmes (para. 376).

106. It would be most useful if developing countries with active programmes of space applications would provide on-the-job experience or training opportunities to persons from other developing countries (para. 377).

107. In order to derive the fruits of space tecnology and use it to accelerate their development, it is imperative that developing countries take steps to work co-operatively and pool their limited resources to derive the maximum benefit (para. 378).

### 2. Conclusions and recommendations addressed to the United Nations and/or international agencies/bodies

108. International funding and technical assistance agencies, when providing expertise assistance, might first seek the necessary experts from developing countries (para. 369).

109. [The United Nations system should provide technical asistance - if required - to decide on the particular parts/components and their quantitites that may be maintained in the proposed regional stores] (para. 372).

110. The United Nations and concerned specialized agencies should examine how best to organize the collection, collation, documentation and dissemination of the experiences of developing countries related to space applications (para. 373).

111. The United Nations and its regional economic commissions should play a role in supporting initiatives for regional space activities (para.374).

112. The United Nations/specialized agencies should, where necessary, be provided with the means to fund expert missions to define specific, need-based, co-operative programmes between groups of developing nations (para. 376).

113. Co-operation in training among developing countries should be actively encouraged by the United Nations and its specialized agencies by providing, *inter alia*, funding for fellowships (para. 377).

114. The proposed new or expanded activities, including personnel costs, of the United Nations are to be funded mainly through voluntary contributions of States, either in money or in kind (para. 416).

115. It is recommended that the General Assembly, through its competent organs, rearrange priorities within the United Nations next regular budget in such a way that the modest increase in personnel costs may be absorbed within the available resources (para. 416).

116. [COPUOS should examine and refer for consideration to the General Assembly how best it can ensure that outer space is used for solely peaceful purposes] (para. 419).

117. COPUOS should continue consideration of the best and most suitable working methods for the Committee and its two sub-committees. It should have on its agenda regular items pertaining to the follow-up of Conference recommendations (para. 420).

118. The primary responsibility for arranging to conduct and/or conducting studies within the United Nations (in association, where appropriate, with concerned specialized agencies and inter-governmental or non-governmental organisations) should remain with COPUOS, which will also have to decide on the most appropriate methods of conducting these studies (para. 421).

119. The United Nations Programme on Space Applications should be directed towards promoting a greater exchange of actual experiences , developing a fellowship programme, helping the development of an autonomous technological base in countries, disseminating information and providing (or arranging to provide), on request, technical assistance (para. 423).

120. The activities of other units of the United Nations system involved in space activities must be continued and strengthened, as appropriate (para. 424).

121. The United Nations should organize an international space information service consisting initially of a directory of information about sources of information and data services (para. 425; see also paras. 203 and 211).

122. One possibility is that a Centre for Outer Space - essentially the Outer Space Affairs Division of the Department of Political and Security Council Affairs with enlarged responsibilities - should be formed. Alternatively, the proposed integration and expansion could take place within the existing Outer Space Affairs Division. In either case, the enlarged responsibilities would include: present tasks of the Outer Space Affairs Division; servicing COPUOS in the implementation of the approved Conference recommendations, with special regard to the proposed studies; conduct of studies if so requested by COPUOS; implementing the reoriented and expanded Programme on Space Applications; organizing and operating the International Space Information Service (para. 427).

123. The present ad hoc Sub-Committee on Outer Space Activities of the Administrative Committee on Co-ordination should continue to meet annually. All the space-related programmes of all the United Nations agencies should be discussed and co-ordinated at this forum before finalization (para. 428).

124. The proposed Centre for Cuter Space or the Outer Space Affairs Division with enlarged responsibilities should work in close co-operation with the various technical agencies in the United Nations system as well as with funding agencies so that proper co-ordination of projects is ensured within the United Nations system (para. 429).

125. It is recommended that the approved proposals of the Conference be forwarded to the funding agencies and bodies with established operational activities, so that they may be taken into account in the planning and setting up of programmes (para. 430).

## Annex II

## LIST OF COUNTRIES WHICH SUBMITTED PENDING AMENDMENTS

The Preparatory Committee, at its fourth session, considered and revised the draft report of the Conference. During the course of its consideration, several proposals and amendments were introduced by members of the Preparatory Committee, many of which were agreed upon. Where there was disagreement, the Preparatory Committee decided to place the original text in square brackets and, immediately following, to place the amendment(s) concerned also in square brackets. As further agreed by the Preparatory Committee, this annex indicates the names of countries which submitted the amendments. It should be noted that since no attempt was made by countries concerned to secure co-sponsors to the amendment, this list does not indicate the extent of support for any amendment. It is intended only for the guidance of the participants of the Conference.

Paragraph 8: United States (addition of (e) and (f))

Paragraph 11: China (second square brackets to replace first)

Paragraph 12: Brazil, Egypt and Nigeria (second square brackets to replace first)

Paragraph 13: Romania (first two amendments)
Chile (third amendment)
Yugoslavia (fourth amendment)

Considered by an informal negotiating group without agreement

Paragraph 64: India (first amendment)
United States (second amendment)
Iraq (third amendment)

Paragraph 150: USSR (deletion of paragraph)
Iraq (deletions in line 6, lines 10 and 11, last 6 lines)

Paragraph 205: Considered with paragraph 13; no agreement

Paragraph 231: Considered with paragraph 13; no agreement

Paragraph 253: Oral suggestions; no agreement

Paragraph 281: No agreement on sentence in square brackets

Paragraph 284: No agreement on sentence in square brackets

Paragraph 306: Oral suggestions; no agreement
Paragraph 360: Oral suggestions; no agreement

Paragraph 372: Sweden (deletion of text in brackets)

Paragraph 419: Considered with paragraph 13; no agreement

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**Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space**

# Report of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

## Corrigendum

Paragraphs 487 and 488 should read

487. President Ronald Reagan of the United States, in his message, stated that the Conference provided leaders from around the globe with an unprecendented opportunity to chart a course for greater co-operation among nations in exploring mankind's last and endless frontier. He urged countries to work together to ensure that the benefits of space continue to contribute to a bright and peaceful future on Earth and to chart new pathways to the stars to serve as avenues of peaceful exploration and adventure for our generation and for generations to come.

488. Following messages from heads of State, the Secretary-General of the Conference, Prof. Yash Pal, made a statement in which he noted that when one spoke of space, the perspective must necessarily be global. One must consider and discuss how space could contribute to the well-being of humanity as a whole. Since 1968, he pointed out, developing countries had made some use of space technology, but their social and economic hopes had not been fulfilled. Indeed, Prof. Pal noted, the gap between rich and poor nations had widened, owing in part to the pattern of use of technology, including space technology. While one could not expect an instant "technological fix", technology properly used could be an engine for development and well-tailored applications could help reduce economic and social disparities. The challenge was to devise methods and means to accomplish that aim on a large scale and in an ongoing manner.

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[Original: English]

[31 August 1982]

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACC | Administrative Committee on Co-ordination (United Nations) |
| AFROSAT | African regional communications satellite |
| APT | automatic picture transmission |
| ARABSAT | Arab Satellite Communications Organization |
| ARSC | African Remote Sensing Council |
| ASEAN | Association of South-East Asian Nations |
| BSS | Broadcasting Satellite Service |
| CCIR | International Radio Consultative Committee (ITU) |
| CCITT | International Telegraph and Telephone Consultative Committee (ITU) |
| CCT | computer compatible tape |
| CFC | chlorofluorocarbon |
| CNES | Centre national d'études spatiales (France) |
| COPUOS | Committee on the Peaceful Uses of Outer Space (United Nations) |
| COSPAR | Committee on Space Research (ICSU) |
| DBS | direct broadcast satellite |
| DCP | data collection platform |
| ECS | European Communications Satellite |
| EIRP | equivalent isotropically radiated power |
| ELDO | European Space Vehicle Launcher Development Organization |
| ESA | European Space Agency |
| ESRO | European Space Research Organization |
| EUTELSAT | European Telecommunications Satellite Organization |
| FAO | Food and Agriculture Organization of the United Nations |
| FES | fluid experiment system (SPACELAB) |
| FGGE | First GARP Global Experiment (WMO) |
| FPM | fluid physics module (SPACELAB) |
| GARP | Global Atmospheric Research Programme |
| GEMS | Global Environment Monitoring System |
| GPS | Global Positioning System |
| GSO | geostationary orbit |
| HDDT | high density digital tape |
| IAF | International Astronautical Federation |
| ICAO | International Civil Aviation Organization |
| ICSU | International Council of Scientific Unions |
| IFRB | International Frequency Registration Board (ITU) |
| IGCP | International Geological Correlation Programme |

| | |
|---|---|
| IGOSS | Integrated Global Ocean Services System |
| IHP | International Hydrological Programme (WMO) |
| IMO | International Maritime Organization |
| IPDC | International Programme for the Development of Communication |
| INMARSAT | International Maritime Satellite Telecommunications Organization |
| INTELSAT | International Telecommunications Satellite Organization |
| INTERCOSMOS | Programme on International Co-operation in the Study and Peaceful Utilization of Outer Space |
| INTERSPUTNIK | International System and Organization of Space Communications |
| IOC | Intergovernmental Oceanographic Commission (UNESCO) |
| ITU | International Telecommunication Union |
| MAB | Man and the Biosphere |
| MONEX | Monsoon Experiment (WMO) |
| NASA | National Aeronautics and Space Administration (United States) |
| NNSS | Navy Navigation Satellite System (United States) |
| NPS | nuclear power source |
| RF | radio frequency |
| SARSAT | search and rescue satellite aided tracking |
| SETI | search for extraterrestrial intelligence |
| SITE | Satellite Instructional Television Experiment (India) |
| SPS | solar power satellite |
| SSTO | single stage to orbit |
| UNDP | United Nations Development Programme |
| UNDRO | Office of the United Nations Disaster Relief Co-ordinator |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| VLBI | very long baseline interferometry |
| WARC | World Administrative Radio Conference |
| WEFAX | weather facsimile |
| WMO | World Meteorological Organization |
| WWW | World Weather Watch (WMO-ICSU) |

## PART ONE

## DECISIONS AND RECOMMENDATIONS OF THE CONFERENCE

### INTRODUCTION

1. Space has always had a special fascination for man, ever since the first intelligent being looked up into the sky. Man worshipped the sun as the life-giver even before science had shown it to be so, and the moon has had an aura of romance around it for centuries. In our collective psyche, space has always meant freedom, romance, the challenging unknown and - for some - "heaven".

2. Now, after millennia of looking upward and outward from the earth, man has acquired the ability to do the reverse also: to look at our home planet from a vantage point in space. What we see is immensely beautiful and very revealing: a lonely, shimmering sphere, abundant in resources, solid and yet very fragile; a planet whose life processes are inextricably interdependent, where life depends upon the delicate and unique balance between man and nature, between man and man. What is not visible is equally revealing: we cannot discern different countries or separate peoples. Space has given us a new perspective on the universe, our solar system and our own planet. Can it also give us a new perspective on ourselves?

3. We are now also able to look out - to other planets, other stars and other galaxies - without having our vision clouded by the haze of the atmosphere, thus allowing us to see farther out and back almost to the beginning of the observed part of the universe. This has helped to confirm increasingly the theory that the universe evolved from a single fireball of energy some 15 billion years ago and that the material which formed our earth and solar system was synthesized in the evolution and explosion of an earlier star, demonstrating our common ancestry and innate unity - not only with each other, but indeed with all things in the universe.

4. Apart from the philosophical and ethical implications of the view from space, there are also immense immediate and future benefits. Communication satellites have virtually revolutionized telecommunications and broadcasting, while earth-observation spacecraft provide meteorological data of great importance and have considerable potential for contributing to resource management systems through remote sensing. Spacecraft are also replacing celestial bodies in space as means for accurate position-location and for navigation. Long-term benefits of our capability to send objects - and people - into space include not only applications in these fields, but also in biology, medicine, materials and, possibly, energy.

5. The rapid growth of space technology and its potential for important applications was already clear in the 1960s and led to the convening in Vienna in 1968 of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. The Conference stimulated a great deal of interest - in both developed and developing nations - in space and its applications.

6. It is now almost a decade and a half since the 1968 Vienna Conference and in this period there have been great strides in space science, technology and applications. These revolutionary developments, this new dimension to which man has now acquired access, have been made possible by the very rapid advances in a number of interconnected disciplines. Within the space of one generation, these advances have led from the launch of the first artificial satellite in 1957 to

manned spaceflight, men and robot vehicles on the moon, automatic landers on Mars and Venus, missions past Jupiter and Saturn, to the first partially reusable launch vehicle and space stations in Earth orbit. Of more direct relevance, we have witnessed the establishment and now routine operation of space communication systems, both international and domestic, of space broadcasting systems, of a global observation system for meteorology, of operational navigation and maritime communication systems and of quasi-operational remote-sensing systems. About 150 countries now use space communication and more than 220 stations for the direct reception of image data from meteorological satellites are in operation around the world. It is estimated that over 100 countries have by now used data from remote sensing satellites and almost 40 countries have already joined the only recently formed INMARSAT. While only two satellites were launched in 1957, the beginning of the space era, an average of some 120 satellites are now launched annually. Such a high level of space activity and the many diverse systems clearly require a degree of international co-operation, co-ordination and regulation. While bilateral and multilateral activities have promoted this, an important role has been played by the United Nations and its specialized agencies. The progressive development and codification of the law of outer space including, in particular, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies and the work done by ITU in the field of radio regulations concerning outer space, have created conditions conducive to the smooth and orderly growth of space activities. However, improvements can be made in the United Nations system in these regards.

7. At the same time, the increasing use of space - for scientific purposes, experimentation and applications - and the growth of space technology, necessitate a fresh look at possibilities, potentials and implications, including possible new legal procedures and institutions. In particular, while the first outer space Conference did a great deal to promote awareness of the immense promise of space, it is now time to proceed further and take appropriate measures for the wider and fuller utilization of space technology. In doing this, there is a special need to examine how the United Nations system can play a more effective role in stimulating the peaceful uses of outer space so as to benefit all countries - including especially the developing ones - and how the United Nations can promote and co-ordinate international efforts to this end. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space was convened to allow wider participation of Member States in the activities of the United Nations in outer space matters and to assess the new developments, to exchange information and experiences on their present and potential impact, and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology.

8. Space science and technology cannot be considered in isolation, but must be seen as an integral part of the totality of science and technology, which in turn form part of the social, industrial, educational and cultural context of human society. The role of science and technology in society and in the process of economic and social development was the subject of the United Nations Conference on Science and Technology for Development held in Vienna in August 1979. The conclusions of that Conference are, in general, applicable to the field of space science and technology. It might be useful to recall here the Preamble of the Vienna Programme of Action on Science and Technology for Development adopted by the Conference:

"1. The United Nations Conference on Science and Technology for Development comes at a critical point in the evolution of the world economic situation and international economic relations characterized by crises in the world economy leading in particular to a further deterioration in the situation of developing countries. Developed countries continue to dominate the field of science and technology to the extent that around 95 per cent of all research and development is executed by them, while developing countries, which represent 70 per cent of the population of the world, have only about 5 per cent of the world's research and development capacity. These figures demonstrate the magnitude of the problem and the task facing the international community. The experience of the last few decades makes evident the need for determined measures on the national and international planes to redress this situation, for without such action the present inequitable situation will be aggravated further and the gap between developing and developed countries will continue to widen.

"2. The necessary resources and technological potentials exist for eliminating the under-development of the developing countries and for improving the well-being of humanity as a whole. The achievement of this goal presupposes that developing countries exercise full control over their own resources. It also presupposes an equitable distribution and creation of scientific and technological capabilities of the world.

"3. The Conference is an integral part of the efforts of the international community for the establishment of the New International Economic Order through the adoption of decisions and the provision of concrete and action-oriented recommendations aimed at the use of science and technology for the development of all countries, and particularly of the developing countries.

"4. The industrialized countries have, through their control of science and technology, provided themselves with an immense power to enhance the human environment, increase production and improve the standard of living of their population. However, their production and consumption patterns have led to a waste of resources and often carried with them negative social and environmental consequences. To avoid such undesirable effects, developing countries should carefully analyse the options in connexion with the choice, development and transfer of technology.

"5. The ultimate goal of science and technology is to serve national development and to improve the well-being of humanity as a whole. Men and women in all groups of society can contribute positively to enhance the impact of science and technology on the development process. However, modern technological developments do not automatically benefit all groups of society equally. Such developments, depending on the given economic, social and cultural context in which they take place, are often seen to affect various groups in society differently. They may have a negative impact on the conditions of women and their bases for economic, social and cultural contributions to the development process. This is seen to happen in industrialized as well as in developing countries. Therefore, steps should be taken to ensure that all members of society be given real and equal access to and influence upon the choice of technology.

"6. Developing countries have long recognized the need to pursue policies of creating the necessary structures at the national level in order to maximize their capacities to develop, absorb and use science and technology as well as to distribute the results of those important tools of development among all sectors of their population. It must however be recognized by the international community at large that there are, and will continue to be, limits to the ability of developing countries to realize their full potential as long as there is no restructuring of existing international economic relations on a just and equitable basis.

"7. International development co-operation in the field of science and technology must assist developing countries in strengthening their creative and innovative capacity and thereby promote their autonomous scientific and technological development. This requires fundamental changes in the present pattern of international relations in this field so as to enlarge substantially international co-operation and thus enhance the opportunities for developing countries in the development and strengthening of their scientific and technological capacities, reflecting the requirements of each country in accordance with its realities and its vision of the future, as well as in the international process of the transfer of technology so as to substantially increase and facilitate such transfers, in particular to developing countries, and to enable them to have significantly improved access to the technology they require, including advanced technology." 1/

9. These observations and the more detailed considerations and conclusions that are contained in the report of the Conference served as an important backdrop for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82).

10. The present report, reflecting the considerations and conclusions of UNISPACE 82, is divided into three chapters. Following the introduction, the next part (chap. I) assesses the present and likely future state of space science and technology. The following part (chap. II) discusses present and potential applications of space science and technology, their implications and the means of ensuring that all countries derive benefits from space. It also examines the choices for countries with regard to space technologies and the difficulties faced in using them. The important issues about the use of the geostationary orbit and access to space technology are discussed, as are matters connected with the compatibility and complementarity of systems and the protection of the environment. Chapter III deals with international co-operation and the role of the United Nations, including especially co-operation between developing countries. It makes recommendations with regard to the future role of the United Nations and financing. In accordance with the agenda, the Conference was not limited to discussions on science and technology, but also considered their relevance to man and his environment. The Conference discussed scientific, technological, social, economic, organizational and other relevant aspects and their interrelationship.

11. The growing range of space applications has brought benefits to many countries. While any developing countries use space technology, they have not yet fully exploited its considerable potential. In fact, only the developed countries with advanced technology can fully exploit these benefits. The international community, and in particular the developed countries with more advanced technology, should intensify their efforts to promote the wider exploitation of space technology by developing countries. Space technology can be a powerful tool to

accelerate national development: it provides a way of leap-frogging over obsolete technologies and getting away from percolation and trickle-down models of development for which developing countries do not have the time. It could effectively deal with the problems of illiteracy, isolation and lack of information afflicting the development process. Depending upon each country's unique social, economic, cultural and resource context, and taking account of other alternative technologies, space could play an important role in specific areas of development.

12. Space technology offers the potential to spur economic and social development of all countries. It is by no means the complete solution to a country's problems neither can there be any generalized prescriptions for the use of space technology. However, it is often a more effective alternative for achieving a given goal and can sometimes bring about a qualitative change by doing things not possible through more conventional means. In this connexion, international co-operation should be seen and conceived as a major instrument in assisting all countries, especially developing countries, to derive the optimum benefits from the application of space technology. However, the future of each country should rest primarily upon itself.

13. The extension of an arms race into outer space is a matter of grave concern to the international community. It is detrimental to humanity as a whole and therefore should be prevented. All nations, in particular those with major space capabilities, are urged to contribute actively to the goal of preventing an arms race in outer space and to refrain from any action contrary to that aim.

14. The maintenance of peace and security in outer space is of great importance for international peace and security. The prevention of an arms race and hostilities in outer space is an essential condition for the promotion and continuation of international co-operation in the exploration and use of outer space for peaceful purposes. In this regard, the Conference urges all States to adhere to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies and strictly to observe its letter and spirit.

15. Space technology has made dramatic progress in our own lifetime. It has changed our concept of distance, made each person the neighbour of all others and given us a new measure of ourselves in relation to the cosmos. Can we now rid ourselves of our obsolescent biases and concepts, and move forward to the more equitable, humane and co-operative society that the image from space conjurs up?

# CHAPTER I

# STATE OF SPACE SCIENCE AND TECHNOLOGY

16. Since the launch of the first artificial earth satellite (1957), and in particular since the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (1968), space science and technology have developed extremely rapidly. Satellites, first used for space research, were soon used for experimental applications as well. Within a decade of the launch of the first satellite, operational space systems were established for telecommunications and meteorology. Today, telecommunications, television broadcasting, meteorology, maritime communication, navigation, global positioning, geodesy and remote sensing routinely make use of satellites.

17. This extensive use of space for a variety of applications has been brought about by the immense progress in space technology. Today, it is possible to launch a payload weighing tens of tons into low earth orbit - compared with the tens or hundreds of kilograms that the early rockets could launch. Many developments, particularly improvements in reliability, in micro-electronics, in materials, in solar cell technology and deployment mechanisms, have revolutionized space technology. Man has not only gone into space, he has also stepped on the moon. Equally impressive missions have been carried out by completely automated spacecraft, responding to commands and relaying data from billions of kilometres away.

18. Space science has made equally astounding progress and in many cases has been the cause of technological developments. It has brought new understanding about the solar system and indeed about the whole universe. Unexpected discoveries have shed new light on the origin of the solar system and of the universe itself. Closer to earth, space science has vastly improved the understanding of the atmosphere and climate, has led to better weather predictions and has aided mankind's efforts to keep the atmosphere within agreeable conditions. Space biology and medicine are completely new fields that may help solve medical problems. Materials science experiments in space should result in the production of better, possibly cheaper and new materials.

19. The present chapter briefly reviews some of the exciting and promising developments in these fields of space science and technology and makes a few suggestions for future action.

## A. Space science

20. The oldest field of space science is, of course, astronomy. Its birth probably dates back to the time when the first intelligent being looked up at the beauty of the star-studded sky. The arrival of the space age allowed man the possibility of observing the universe from outside the earth's atmosphere. For looking at the planets, the sun, the stars, our galaxy and other objects extending into the deep depths of space (and billions of years backwards in time), this was like removing blinkers from his eyes. The maximum emission of the sun's energy occurs in the same narrow band of wavelengths in the optical region of the electromagnetic spectrum to which the earth's atmosphere is transparent; it is no accident that the range of sensitivity of our eyes is also confined to precisely

these wavelengths. Even in this narrow band of wavelengths, our ability to distinguish between various objects is greatly enhanced because we have the faculty of separating different colours (i.e. by different responses to different wavelengths). Outside the atmosphere the extraterrestrial signals cover a wavelength range millions of times larger than the optical band. An ability to detect those signals and analyse them can, therefore, provide an enormous amount of new information about the nature of astrophysical phenomena. Indeed, every time a new window for astrophysical observations is opened, we find things which had never been expected by the most imaginative of scientists, even though practically everything we do find can be ultimately understood in terms of the physics we learn here on Earth. One such window was opened by the discovery of radio astronomy in the 1930s. This did not have to await the arrival of the space era, since radio waves at wavelengths between a few centimetres and several tens of metres are not significantly attenuated by the earth's atmosphere or by the ionosphere. It was soon found that not only does our Sun emit radio waves, but there are a large number of sources - compact and diffuse - in the universe which emit a significant fraction of their energy in the form of radio waves. By building larger and more sensitive instruments and inventing auxiliary observational techniques, man's radio-visibility was extended to much further distances than was possible through observations with optical telescopes.

21. But for the techniques of radio astronomy, we would still be ignorant about a great many phenomena in the universe. Amongst them are the cosmic background of black-body radiation representing, most probably, the cooled down remnant of the hot fireball associated with the very early phase of the universe some 15 billion years ago, and the existence of a host of organic molecules in interstellar space. Different happenings and things in the universe can manifest themselves at different frequencies and unless we tune in, we will not be able to put the pieces of the picture together.

22. Observations in the ultraviolet, X-ray and gamma ray wavelengths are possible only from the top of the atmosphere, using balloons, rockets and especially satellites. These observations have led to some of the most remarkable advances in astronomy in the last 20 years. Some of the new understanding relates to the high temperature and dynamical phenomena on the Sun. That the Sun has a high temperature corona was directly verified through the observation of soft X-rays. X-ray and ultraviolet observations have shown similar and more extensive coronal features around other stars. Like the sun, most stars have stellar winds, and a great deal of the stellar surface material is continuously cast out into space, often in great bursts.

23. About a thousand X-ray sources have been observed since the almost accidental discovery of X-ray sources during a rocket flight. X-rays are emitted from galaxies, quasars, diffuse envelopes and remnants of supernova explosions, compact objects such as neutron stars - alone or in close-binary systems - and by hot intergalactic matter. Some of the objects emit 10,000 times as much energy in X-rays as the total energy output of the sun. A picture begins to emerge, with crucial support from X-ray observations from space, that compact objects and close binary systems are fairly abundant in the universe. The discovery and analysis of the X-ray pulsar phenomena form one of the most exciting chapters in modern astronomical history.

24. Gamma rays are simply X-rays of much shorter wavelength or higher energy per quantum. Gamma ray emission has been observed from supernova remnants, some

pulsars, and from the disc of the galaxy. Since high energy (most probable energy about 100 MeV) gamma rays can be produced in interactions of high energy cosmic-ray particles with matter, they provide a powerful tool for surveying matter density and cosmic rays in interstellar space. Positive and negative electrons can annihilate each other in slow collisions, resulting in gamma rays of energy close to 0.5 MeV. Such a gamma ray line has been observed towards the centre of our galaxy. Intense bursts of X-rays and gamma rays from some objects (so called "bursters") have challenged the understanding of astrophysicists.

25. Observational evidence for the existence of compact, dense objects like neutron stars on the one hand and possible existence of an early hot dense state of the universe on the other, is beginning to provide new insights and constraints on our ideas about the basic structure of matter and the relation between fundamental forces of nature. In this sense many of the observations in astronomy simultaneously impact our understanding of sub-nuclear physics and cosmology.

26. Immediately on the longer wavelength side of the visible spectrum lies a long band of infra-red wavelength extending from 1 micrometre (um) to about 100 um. The earth's atmosphere allows specific narrow parts of the near infra-red spectrum to pass through without significant attenuation. During the last couple of decades many surprising discoveries have been made with ground-based telescopes. Many objects are found to emit significantly large amounts of energy in the infra-red wavelengths. Longer wavelengths ($>$ 20 um) have been accessible only through balloon and rocket observations. Many cool stars and clouds have been discovered and studied. When infra-red telescopes are deployed in space, many new aspects of the galaxy and the universe will reveal themselves for the first time. Particularly interesting is the possibility of observing the slowly contracting clouds of material on their way to becoming stars like our Sun.

27. Balloon and ground-based observations during the last 30 years or more have already established that cosmic rays consist primarily of atomic nuclei, extending from hydrogen to uranium, accelerated to extremely high energies. The energy spectrum ranges over many orders of magnitude and the highest energies are far beyond any values we can hope to achieve in our accelerator laboratories. The relative abundance of different elements and the spectrum at low energies have been established by many clever experiments aboard satellites. Lower down in the atmosphere the cosmic ray nuclei break up in nuclear interactions with air nuclei and many new species of short-lived and stable particles are produced, some of which propagate deep into the earth. Precise elemental and isotopic composition of cosmic rays, as also their energy spectrum, carries very significant information about the sources, the acceleration mechanism and the propagation of this radiation. Some of the most important parts of this information can be obtained only through space observations. This cosmic ray signal is valuable because it is the only form of particulate matter which comes to us from the depths of space, carrying with it the signature of rather unique cataclysmic events in which it is produced and accelerated, as also the scars of its encounters wih intervening matter and radiation.

28. Space astronomy, as discussed in the previous paragraphs, is but a form of very remote "remote sensing". Space capabilities also allow us the possibility of going close to some of the objects and phenomena and studying these at near range or in situ. This is at present possible only for the region of the galaxy confined to our own solar system, since a return voyage to even the nearest star seems at present impractical in terms of both cost and elapsed time.

29. The study of the solar system, particularly the motions of the planets, was perhaps the first "science" that preoccupied man. The order and predictability of the planetary motions pointed strongly to the existence of a natural law and finally resulted in the founding, by Kepler, Galileo and Newton, of the first and most basic branch of physics, namely, dynamics and universal gravitation. It is no wonder, therefore, that soon after the dawn of the space age, a visit to the moon and the near planets of the solar system was put high on the agenda. Modern space observations have been used to study - besides the sun - Mercury, Venus, Earth, Moon, Mars, Jupiter, Saturn and the four Jovian satellites. For obvious reasons, the most intensive studies have been concentrated on the earth and its environment.

30. Man has landed on the moon and several hundred kilograms of lunar material have been brought back to the earth, both by manned missions of the United States and unmanned robots of the Soviet Union. A study of this material by hundreds of scientists around the world has provided new and valuable information about the chemical composition, structure, and evolution of the moon: the history of the cratering process, size distribution of micro-meteorites and the prehistory of low energy cosmic rays and the solar wind. The instruments left on the moon have continued to give data on the heat outflow and moon-quakes, rare though they are. There is no evidence of current volcanic activity. By now we know more about the moon than about any other planet in the solar system, except Earth.

31. Besides the moon, man has been able to land instruments only on two other planets, namely, Venus and Mars. Several landers on Venus provided atmospheric and soil analyses and transmission of panoramic pictures of the surface. Venus was and remains very interesting because, in terms of size and distance from the sun, it is the planet most similar to Earth. On the other hand, its atmosphere is principally carbon dioxide with considerable traces of noble gases, with a pressure 100 times greater than the atmospheric pressure on the earth. The surface temperature is about 470°C. There is indication of fairly active geological history, with volcanoes and craters still discernible. Direct determination of the elemental composition of Venusian soil and analysis of panoramic pictures from Venera landers confirm volcanic activity on Venus. One of the most interesting findings is that Venus and Mars both lack any measurable intrinsic magnetic fields. This places severe constraints on any theories to account for the intrinsic magnetic field of the earth.

32. Planetary bodies similar to the earth in composition, size and orbit are compatible with atmospheres which may or may not be able to support life. It follows that a thorough scientific understanding of the limits of stability of the terrestrial atmosphere under the impact of man-made modifications is one of the most urgent tasks of space science.

33. Mars has always been an intriguing planet because of early speculation about the possible existence of life on it. It has been studied by several space missions, including landers, which provided spectacular photographs of the surface and analysed the soil for its chemical composition and evidence of biological activity. The atmosphere of Mars is rather thin (about 0.6 per cent of the earth's atmospheric pressure) and, as on Venus, consists mainly of carbon dioxide with 1 to 2 per cent of nitrogen and argon. There is no indication of any biological activity, though surface features suggest running water and catastrophic floods some time in the past.

34. Mercury has not been studied very intensively, though a most significant discovery by the very first fly-past mission was that of a weak intrinsic magnetic field. Mercury is very hot on the sunlit side and very cold on the other. The surface is heavily cratered like the moon, and the planet is too small and close to the sun to have an atmosphere.

35. Of the giant planets (Jupiter, Saturn and Uranus), Jupiter and Saturn have already been observed by planetary probes. Jupiter is the largest planet in the solar system, with a mass greater than that of all the others put together. Like the other two giants, Jupiter is really a proto-planet, in the sense that it is in the same state as it was when formed 4.6 thousand million years ago and has not lost its lighter elements or noble gases. Thus the most abundant elements are hydrogen and helium and there is no solid crust like the one on the terrestrial planets. Its atmosphere is about 1,000 kilometres thick and, besides the above two gases, contains methane and ammonia. The atmospheric phenomena are grand and have been observed in some detail by visiting spacecraft. Winds up to 400 km/h have been observed. The atmosphere has a large scale banded structure caused by the effect of rapid rotation of the planet (about 10 hours) on convection currents. In addition, there is an endless variety of eddies or turbulences, the most prominent of which is the famous Great Red Spot, which has varied somewhat during the 300 years it has been observed. The formation and persistence of this phenomenon is still not properly understood.

36. Jupiter emits about twice as much energy as it receives from the sun, and, indeed, can be considered a micro-star. It has a strong magnetic field, about 10 times the earth's value, at its surface. Jovian magnetospheric phenomena have been studied in great detail by various fly-by missions. Particles are accelerated and produce radio waves in interaction with the magnetic field. In fact Jupiter is the strongest radio source in the sky.

37. The largest four satellites of Jupiter were discovered by Galileo, in the earliest observation of the heavens by a telescope. Of these, two are about the size of the planet Mercury, and the other two the same size as the moon. By now the number discovered has increased to 16, including those seen by spacecraft. Thus Jupiter as a minor solar system represents an excellent astronomical laboratory. Some of the satellites have been studied by the Voyager spacecraft and have revealed interesting and differing features. One of these, Io, though only the size of the moon, has been found to be the most volcanic object in the solar system. It is believed that Io is an important source of the plasma that populates the magnetosphere of Jupiter, and of the radio-emission therefrom. It is probably because of the influence of Io that the radio emission of the planet shows a 10-hour variation, a period which is the same as the rotation period of the planet. In this sense Jupiter is also a "pulsar", the nearest one to home.

38. Saturn has many properties in common with Jupiter as one of the giant planets. A most interesting feature of this planet is its spectacular rings. These have been studied in fair detail by the two Voyager spacecraft and have revealed many new features. The role of small moons in the evolution of the ring structure is beginning to be understood. Many of the newly discovered radial features are yet to be explained properly.

39. The discovery of radiation belts by Explorer-I and the detection of the solar wind by Lunik-2 initiated a new and active field of research in solar terrestrial relationships. Radiation belts are produced by a large population of low-energy

charged particles trapped in the earth's magnetic field. Most of the particles in the belt are captured from the solar wind, though some are accelerated within the belt.

40. The sun interacts with the earth not only through its light and heat, but also through emission of some of its material in the form of ions and electrons, which impinge on top of the magnetosphere of the earth. This stream of plasma, called the solar wind, varies in temperature, intensity and speed. The plasma also carries along a magnetic field, essentially stretched out from the sun to fill the interplanetary space. The solar wind is the source of the bulk of the particles in the radiation belts. Interaction of the solar wind with the magnetosphere produces a magneto-pause on the sunlit side, preceded by a bow shock, and stretches out the earth's magnetic field into a long tail on the opposite side. The solar wind is also the cause of the formation of the magnetospheres of some other planets. The earth's magnetosphere contains a population of charged particles, mainly electrons and protons, of solar wind origin. These are found to cause geomagnetic disturbances and provide the excitation mechanisms for auroral emissions at high latitude. Particles precipitating in the auroral regions are also the source of strong radio emissions from the earth.

41. Space observations have unravelled many of the features of this complicated interaction, though several aspects are still not well understood. In situ measurements of the solar wind and magnetic fields have been made by several space missions, but all these are confined to regions of interplanetary space close to the ecliptic. The out-of-ecliptic mission planned for the near future will add significantly to our understanding of interplanetary phenomena.

42. Study of solar-terrestrial phenomena is important in its own right because a great deal of distant and inaccessible astrophysical phenomena must be of a similar nature. A wide range of solar-terrestrial variations can also produce effects on a number of practically significant areas such as communication, transport, power and energy, space systems, navigation and, perhaps, weather and climate. Winds and storms that rage in the plasmas and magnetic fields existing from the top of our atmosphere to the solar surface have effects on man which in their own right can be as potentially hazardous as the atmospheric storms which sweep across the earth's surface.

43. Space science and space scientists have provided the cutting edge of developments in space technology. Discoveries in science are not made only through design of instruments or observation. Equally important is the work of the theoretical scientists who work at producing coherent systems out of the mass of data and suggest further experiments. But without the capability to observe, there is no stimulation and no proof. And very seldom does man have an imagination as rich as nature itself displays. Observations are, therefore, essential.

44. In a short span of 25 years, our picture of the universe has been transformed because of the new observations made in the space era. However, what has been done so far is mere reconnaissance, and the real observational phase is yet to begin. Many surprises and many discoveries lie ahead awaiting the time when more or less permanent space observatories are established. In addition there will be a continuous need to have autonomous experiments for following specific leads. Space science should, therefore, continue to have a high priority; in fact, in view of its promising future, it is desirable that support be substantially increased.

45. In the case of space science missions a healthy tradition of co-operation has been established over the years, allowing experimental payloads from scientists in different countries to be put on spacecraft launched by other countries. Many co-operative experiments have been done by scientists of various countries using balloons, rockets and satellites. In more recent years, international crews - from both the developed and developing countries - have been provided opportunities for participating in experiments on orbital space stations. It is desirable that such co-operation continue and be further encouraged. Major space observatories to be set up in the future should also be open to scientists and experimenters from all countries, continuing the tradition of scientific co-operation and "guest observers" in many existing earth-based observatories. Scientists from all countries should be encouraged to use these facilities.

46. It is sometimes argued that basic science in general, and space science in particular, are not important in a world pressed by practical problems. This is not correct. Besides the fundamental argument that an understanding of the universe we live in is important in its own right, it is also true that initiatives in space applications have most often been taken by people who were earlier motivated by their interest in space science. The encouragement of space science and space astronomy in the universities and institutions of developing countries could, therefore, provide an important stimulus and strong support to the development and practical applications of space technology.

47. This brief survey obviously cannot cover adequately the vast and growing field of space science. While aspects related to space biology and medicine and to materials science in space are discussed in the following section, a slightly more detailed exposition can be found in Conference background paper A/CONF.101/BP/1.

## B. Experiments in space environment

48. Space provides an environment that cannot easily be reproduced on Earth: a virtual absence of gravity (micro-gravity), access to that part of the cosmic spectrum of radiations which cannot be sampled and studied on Earth and a virtually infinite source of near-vacuum. On Earth, all materials and organisms are subject to the force of gravity. The flow of liquids, the convection of fluids, the growth of plants and animals and the physiology of people are all determined or strongly influenced by gravity. Therefore, space provides a unique opportunity for studying the effects of micro-gravity and/or vacuum on life processes, man and materials.

49. There are many well-known effects of gravity in fluid systems including buoyancy, convection, sedimentation and segregation. One important phenomenon is gravity-driven convection currents in fluids, which are, in most cases, oscillatory or turbulent. In a micro-gravity environment, the relative importance of convection, diffusion and surface forces may be changed drastically. In space, crucible-free zone-melting of single crystalline materials or metals is possible without restriction by gravity effects.

50. Materials science experiments in a space environment, coupled with ground-based research, should lead to a new understanding of the basic processes. Fluid physics, chemistry, metallurgy (including composite materials and glasses), single crystals and pharmaceuticals represent specific areas of activity.

51. Single crystal growth studies require furnaces with precision temperature measurements. Such monocrystals, which are very important semi-conductor material, have been grown in numerous experiments both aboard the United States Skylab as well as under the USSR and the INTERCOSMOS manned space programmes aboard Salyut-6. Study of melting and solidification processes and tests of electron-beam welding in space were carried out by the USSR as early as 1969 using the "VULKAN" unit on Soyuz-6. Apollo 14, 16 and 17 carried several small micro-gravity experiments including composite casting, electrophoresis and fluid transfer in preparation for similar larger experiments aboard Skylab. Micro-gravity experiments were also carried out during the joint Apollo-Soyuz Test Project. A few countries have also flown miniature space processing laboratories on board high-altitude rockets, which can provide a few minutes of micro-gravity conditions. Limited experiments have been conducted using aircraft trajectories and drop towers, providing respectively up to one minute and a few seconds of simulated micro-gravity conditions. It is likely that not too far in the future, semi-conductor materials which are difficult and expensive to produce on earth with the degree of purity and perfection required by modern electronic and micro-electronic industry will be manufactured in space. Likewise, the possibility of producing specialty glasses and products and advanced alloys is being considered. Over-all cost-benefit assessments, however, are still rather controversial.

52. Space-processing also seems very promising for the production of pharmaceuticals such as erythropoietin to stimulate red-cell production in fighting kidney and blood diseases, anti-haemophilic factors to clot blood in haemophiliacs, urokinase to reduce clotting in stroke and phlebitis victims, and beta cells which might provide a single-injection cure for diabetes. Electrophoretic chambers for the experimental processing of such biological products will be flown aboard the Space Shuttle.

53. A number of materials science experiments will also be carried out by European countries and the United States, using the SPACELAB. Facilities for these include the special fluid physics module (FPM), developed in Italy, to be flown on the first SPACELAB mission, and a fluid experiment system (FES), under development in the United States, to be flown during future SPACELAB flights. The FPM will investigate fundamental fluid physics problems such as natural and enhanced column stability, convection, drop coalescence, liquid/vapour interfacial forces, etc. The FES allows fluid phenomena investigations using optical observation techniques. Its data capability includes holographic photographs and a flow visualization video system.

54. Much work remains to be done in material sciences to develop a better understanding of the various processes involved. In order that rapid progress be made in this field, it is essential that the results of experimentation continue to be widely disseminated and readily available to scientists all over the world. There is now an increasing probability of economically viable production in space of new materials in the near future. It is desirable that the benefits of these developments be made available on reasonable terms to all nations and all mankind (see also chap. II, paras. 306 and 307).

55. Early experiments with animals in space were quickly followed by manned missions of gradually increasing duration. Man demonstrated his ability to function in space and was given increasingly complex tasks. In a number of cases astronauts and cosmonauts solved problems that would have crippled unmanned vehicles. There were, however, physiological effects of micro-gravity, both during

and after spaceflight, that at first appeared to limit the effectiveness and the duration of manned missions. "Motion sickness" limited effectiveness in some cases but was found to disappear after a week or two. Loss of calcium from the bones, muscular atrophy and redistribution of body fluids caused problems, but these were eventually largely overcome by physiological adaptation, rigorous exercise and devices to simulate the effects of gravity. Cosmic radiation also poses a hazard, particularly in the radiation belts, but space vehicles can be shielded to the extent that long duration missions in low earth orbit and short missions through and outside the belts can be reasonably safe.

56. Manned space missions and general scientific interest stimulated work in the field of space biology and medicine. Neither the microgravity environment nor the complex spectrum of space radiation can be produced or effectively simulated in ground-based laboratories. Consequently, studies of the influence of these factors on living matter will only be possible to the extent that experimental facilities in space become available. Both factors have at least two characteristics of exceptional biological interest: they have not been encountered by living organisms throughout the entire history of their terrestrial existence and evolution, and living organisms display varying degrees of tolerance of each factor, permitting varied and systematic quantitative experiments to determine the nature and extent of their effects. For biology and medicine, space therefore represents a new and powerful research environment: it makes possible experimental investigations into problem areas in which theory is in no position to make trustworthy predictions.

57. Our current state of knowledge in this field derives from experiments carried out in space over the last two decades, notably those conducted during recent years in the United States Skylab and the USSR Cosmos Biosatellite and Salyut series. Of the problems that have so far aroused interest, and continue to do so, many involve fundamental issues in the biosciences. Cardinal questions concern the biological significance of earth's gravity. Gravity strongly affects the behaviour of the liquid and semi-solid phases which comprise living matter. It always existed as it does today, and the evolution of all organisms has therefore taken place under its constant and pervasive influence.

58. Important experimental facilities already exist or are being developed in many countries for research in the following areas:

(a) Basic physiological phenomena with respect to the three main sensing systems (vestibular, somatosensory and visual) related to spatial orientation, control posture and locomotion;

(b) Cardiovascular phenomena and conditioning of the cardiovascular system during prolonged exposure to weightlessness;

(c) The possible effect of micro-gravity on cell proliferation kinetics;

(d) Cell and molecular biology.

It is desirable that opportunities to use these and other facilities continue to be made available to scientists of all countries - especially of those that do not now have the capability of setting up their own experimental facilities for such work - in a co-operative and co-ordinated manner. The results thus obtained would also be useful for clinical medicine and public health care. Techniques resulting from medical studies in space could be used on Earth for health care and clinical medicine, as has been mentioned in other bodies of the United Nations.

59. The USSR has conducted a number of long-duration space flights, resulting in a great deal of important medical data. A major conclusion has been that there is no indication of the impossibility - or of hazard - to future extended manned space flights. This is especially important in view of the likely need for human intervention for fabrication or erection of large structures in space, for which concepts and designs already exist. A significant part of the scientific research programme of Soviet manned flights has been concerned with biological experiments. Fundamental vital activities - heredity, cell division, embryonic evolution processes, structure formation, etc. - were studied. Important data on gravitational biology, cytophysiology, comparative and evolutionary biology have been obtained.

60. While most biological experiments in space have focused on the practical problems of manned space flight, some missions have studied the fundamental biological effects of micro-gravity. Effects of stimulated growth of micro-organism, muscular and skeletal abnormalities in rats and multidirectional growth in plants have been noted as preliminary observations. Data from planetary landing missions have been analysed with regard to the possibility of life. In the case of Mars, which seemed promising for the existence of life as we know it, a number of experiments conducted by the US Viking spacecraft on the planet's surface were specifically designed to detect biological activity, and yielded generally inconclusive results. While there is yet no reason to believe that life should be unique to Earth, there is as yet no observed evidence of life elsewhere. However, the implications of life elsewhere in the universe would be profound for science as a whole.

61. Experimental research in the micro-gravity environment is a rapidly growing space discipline which will lead to advanced scientific knowledge and new applications. The research will develop through utilization of existing and planned manned space systems. There is also a clear trend to utilize fully automated orbital platforms which will provide microgravity conditions, energy, power, control mechanisms, etc., and will guarantee the recovery of samples and test objects. Examples of fully automated systems are biosatellites of the COSMOS series, the proposed Space Shuttle long-duration experiment facility, the unmanned modules of the Salyut system, and the projected materials experiment carrier (NASA) and MINOS (CNES). In view of the long-term implications of this work and its interest to humanity as a whole, it is desirable that research in this field be supported and carried out in a co-operative and co-ordinated manner.

## C. Telecommunications

62. Telecommunications was one of the first applications of space technology and, beginning with the passive relay of voice and video by a satellite in 1960, it progressed very rapidly to operational international service in 1965, using active geostationary satellites and satellites in high elliptical orbits. Communication satellites have now become a routine and vital element of the international telecommunications network. They have also become an integral part of the domestic network in several countries. As on 31 December 1981, a total of about 220 satellites for various telecommunications purposes (including broadcasting, meteorology and other services, as well as experimental) were already in operation

or notified to the ITU as planned for operation in the geostationary orbit. Of these, about 63 satellites are for international public telecommunications services (INTELSAT, INTERSPUTNIK and INMARSAT). Of the approximately 157 remaining satellites, about 128 stand notified by developed countries and about 29 by developing countries.*

63. The rapid advances in this field have been made possible by the tremendous technological progress in related fields, especially micro-electronics (large and very large-scale integration), transmitters (travelling wave tubes and solid-state devices), antenna design, high-frequency techniques, communication techniques, micro-processors and the field of electronics in general. While these fields have contributed to space, there has been a corresponding positive feedback and space technology itself has accelerated - even caused - some of these developments.

64. These and other advances led to the development of large, high-power spacecraft which could be kept relatively fixed on-station in the geostationary orbit, making possible a technology inversion by which the complexity was shifted from the ground to the spacecraft. Further progress especially in the field of deployable antennas and solar arrays on spacecraft, led to the development of the direct-broadcast satellite. The first of these was the United States ATS-6, launched in 1974 and used extensively by the United States, India and other countries for experiments in direct broadcasting to augmented community television receivers. Similar experimental satellites have been developed by the USSR and Japan and jointly by Canada and the United States. The USSR, in fact, has had an operational satellite broadcasting service (EKRAN) since 1976, and Canada operates an experimental television broadcast service using its ANIK-B spacecraft. Much current activity in this field is directed towards the development of larger, more complex, more powerful and capable satellites.

65. The technology-inversion mentioned above inevitably results in significant cost increases for the satellite. While the economic attractiveness of this depends upon an over-all system cost analysis of alternative configurations, complex and large satellites are often economical because of the substantial savings in ground segment that they make possible. Such satellites could perhaps contribute to a desirable reduction of pressure on the geostationary orbit. The use of such satellites - with the large investments involved - also implies a very extensive ground segment, so as to fully utilize them. In fact, in many such systems the ground segment (especially when maintenance and operation are taken into consideration) accounts for a large proportion of the total system cost. There is, therefore, a great need for reductions in the cost of ground hardware, and all work aimed at doing this is worthy of encouragement and support by all countries and international organizations. This is also important in the case of international or regional systems, where the space segment may be rented or its

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* These figures are based on notifications made to ITU under the procedures of the Radio Regulations and must be interpreted with caution for purposes not connected with the applications of these regulations. It should be noted, for example, that within the INTELSAT system, about 24 countries lease or plan to lease capacity for domestic purposes (including about 18 developing countries) and that some satellites notified by a single country (e.g., for meteorological services) may be of benefit to many countries.

cost shared between many countries, but the cost of each ground installation is borne fully by the country concerned. It can be expected that the technical development and the greater production due to higher demand will lead to a substantial reduction in cost for, inter alia, ground segment hardware.

66. Most communication satellites are in the geostationary orbit. Since these satellites operate within limited designated frequency bands and therefore need to be sufficiently separated to avoid interference with one another and also possible collisions, there is a limit to the total number of satellites that can operate in the geostationary orbit in the different frequency bands and also in any given frequency band. There is real concern that some parts of the orbit are approaching saturation in certain frequency bands. Technological advances are under way, however, which will probably permit among other changes, the closer spacing of satellites and their satisfactory coexistence. It is therefore imperative that studies and research to achieve this objective be intensified, including a closer examination of techno-economic implications, particularly for developing countries in order to ensure the most effective utilization of this orbit in the interest of all countries. Besides those efforts, and bearing in mind that the geostationary orbit is a limited natural resource, thus it is imperative that its use be properly and justly regulated. These aspects are discussed in greater detail in chapter II G.

67. Advancing technology and increasing traffic have led to decreasing cost per circuit for satellite communication (e.g., the INTELSAT satellite utilization charge per circuit has been reduced by a factor of six since 1965). Traffic has also increased from 150 half circuits in 1965 to 50,244 half circuits in 1981. The share of the developing countries in this traffic was nil in 1965 and about 35 per cent in 1981. Another major factor in the decreasing cost of satellite circuits has been the increased lifetime of satellites. Reliability and quality assurance have helped to do this and, at the same time, have spread the culture of reliability engineering and failure analysis to other sectors of industrial effort, with very beneficial results. Launch vehicles capable of carrying larger payloads have also contributed to the economics of satellite communication.

68. The possibility of launching, deploying or even fabricating large structures in space (see chap. II I) could lead to another revolution in space communication. Such structures could have large antennas and high power outputs making possible communication between extremely small terminals. The possibility of "repairing" satellites in orbit would also make possible the use of more sophisticated systems, thereby permitting simpler ground equipment for reception. Advanced concepts like on-board (spacecraft) switching and signal processing combined with new communication techniques (spacecraft switched TDMA, code-division multiple access, etc.) could even make possible pocket size, individual "earth stations". There are however constraints on the realization of small terminals in particular frequency bands due to the power flux density limitations necessitated by the fact that these bands are shared by ground and space services. Given the large investment in existing ground (conventional) systems and their importance, regulatory provisions have been specified by WARCs and regional radio conferences. In view of the immense possibilities opened up by advancing satellite communication technology, it is desirable that ITU continue to study the optimum allocation of bands for various services, the criteria for sharing and the use of the geostationary orbit with a view to adopting appropriate changes at future WARCs or regional radio conferences.

69. While greater radiated power from the satellite enables reception by simpler ground equipment, the use of smaller antennas on the ground requires wider spacing of satellites in the geostationary orbit in order to reduce interference to acceptable limits. And because greater radiated power by satellites and the use of small antennas on the ground increase possibilities of interference in terrestrial and satellite services, we have a paradox that is common to other sectors of activity also: the intensive application of an innovation often degrades some of its most desirable features. Careful studies of various trade-offs are therefore needed to arrive at an optimum solution.

70. However, partly because of the existing constraints, exciting new developments have been taking place in higher frequency bands. The 14/11 GHz band is already being used for operational purposes by INTELSAT and some countries have carried out experiments in the 20 and 30 GHz bands. Satellite television broadcast systems in the 12 GHz bands will soon be operational as well. Other techniques such as polarization diversity and spot beams may also help to reduce intersatellite interference. Satellite-to-satellite links will avoid multiple hops and may increase the efficiency of global communication. All these developments may also contribute to a lessening of the pressure on the use of GSO in certain frequency bands and orbital arc-segments, mentioned earlier, and deserve active support.

71. Large "space telephone exhanges" have been proposed, which would be electronic exchanges in space, receiving, processing and transmitting signals to appropriate locations through large, narrow beam antennas. Such structures are now feasible and most of the technology for implementing such a system is already at hand, although its launch and assembly may at the moment be difficult and uneconomical. Nevertheless, it is possible that such a system may one day become economically attractive; in this case the development of a large communications platform could be undertaken to satisfy, in the most economical way, the needs that would appear at the international or regional level. The expected impact of such (and other) large platforms, on GSO must be thoroughly studied in order to avoid any unnecessary congestion in GSO, taking into account the equal rights of all countries to this particularly important international resource.

72. An alternative to such single large platforms, and one that may be immediately feasible, is clusters of (electronically) interconnected satellites. Since these could basically serve the same purpose as single large platforms, and both will also be more efficient from a GSO-usage point of view, its development too should be encouraged. Unnecessary congestion in GSO should be avoided taking into consideration the equal rights of all countries to GSO which is one of the most important international resources.

73. A recent development of great promise is the rapid progress in the field of fibre-optic technology. It is desirable to take maximum advantage of this to accommodate international and trans-oceanic traffic so as to lessen the pressure on the geostationary orbit and the frequency spectrum.

74. Satellite broadcasting is an increasingly important application of space technology. Satellite sound broadcasting to portable and automobile receivers is likely to be possible in the future and CCIR has only recently completed a study on this. The use of satellite broadcasting - especially for education - is discussed in greater detail in chapter II E.

75. The increasing power that enables satellites to broadcast directly to small home or community receivers and high gain receiving systems on satellites makes possible communication with small receivers and transmitters on ships, aircraft or ground vehicles. The system of INMARSAT for global maritime communications is now operational, and it is desirable that technologies and systems be developed that will enable smaller ships as well to use satellites for maritime communication (see also chap. II, para. 157). Currently, joint studies and developments have been undertaken by INMARSAT and IMO in close co-operation with CCIR aimed at the establishment of a future global maritime distress and safety system. In this new system Morse radiotelegraphy will be replaced by digital selective calling, radiotelephone and narrow band direct printing using terrestrial or satellite communication facilities. It is intended that distress alerting via satellite will primarily use small low-power distress transmitters that can be carried both on ship and survival craft or be fitted into floating buoys and be activated should a ship sink. The implementation of this future system is envisaged around 1990. This system together with the availability of low-power distress transmitters could be of great value, especially for those developing countries that constitute archipelagos with extensive small ship traffic between their numerous islands or countries with considerable fleets of small coastal or fishing boats. Satellite systems for aeronautical and land-mobile communications are also likely to be developed in this decade. The International Conference on the establishment of an international maritime satellite system, 1975-1976, recommended the study of multipurpose satellites providing both a maritime mobile and an aeronautical mobile capacity. There may be economic advantages to be gained from multipurpose satellites serving both the maritime and aeronautical communities, although the operational and institutional consequences of such an arrangement need to be studied. In an attempt to encourage studies on purely technical aspects, the INMARSAT Council has indicated that the INMARSAT space segment could be used for test and demonstration purposes for a wide range of mobile satellite terminals. ICAO, in 1981, completed a comprehensive study which assesses on the basis of extensive computer simulation the potential and economic viability of an aeronautical satellite system as compared to existing and possible alternative aeronautical communication systems. The early implementation of a suitable system should be encouraged (see also chap. II, para. 159).

76. Lightweight transceivers which operate using appropriate satellite links are especially attractive for use in disaster relief operations and in the dissemination of warnings of impending disasters. Such a system, providing ready and reliable communication with disaster sites, could be defined through an analysis of detailed operational requirements and should be implemented operationally. International organizations which operate commercial components of such a system should make these components available at minimal or no cost during disaster operations. An appropriate body of the United Nations system should be mandated to govern the over-all operations of the disaster operations communications system. The INMARSAT system is already available for disaster relief communications on land through the use of transportable ship terminals.

77. Satellite communication is being put to wider and newer uses. These include video conferencing and various types of interactive use, computer interconnection, data communication, electronic mail, etc. While these basically use the technology of "conventional" satellite communication, they depend on new interface equipment, special software and new communication techniques like packet switching in its various forms. Techniques such as spread spectrum, demand assignment, multiple access, digital speech interpolation, etc. have by themselves created major

advances in the field of communication. Much of this depends upon very basic, fundamental work in such fields as communication theory. Similarly, the use of higher frequencies depends upon extensive scientific investigation of propagation phenomena. It is therefore necessary that all possible encouragement and assistance be provided - especially to developing countries - to undertake such basic science pursuits.

## D. Meteorology

78. Both meteorological as well as earth resources and environmental satellites use remote sensing techniques. They can be considered as complementary and partially overlapping subsystems of a global earth-observation system. This is the reason why certain "remote sensing" applications such as large-scale air and water pollution monitoring are also referred to in this section.

79. Despite the impressive developments in technology, man is yet dependent on the weather for a large proportion of his sustenance and wealth. In fact, a better understanding of the environment has further emphasized his dependence on weather and on the climate. All countries are - to a greater or lesser extent - affected by adverse weather phenomena and climate changes. Developing countries are particularly dependent upon the weather and its vagaries - not just for food, but also for agriculture-dependent industries (e.g., textiles), cash crops like coffee and tobacco, and also for hydroelectric power. Forecasts that are even slightly more accurate or can be made a little more in advance would mean a great deal, both economically and in terms of advance action to prevent human misery caused by storms, floods and droughts.

80. In the few years since the transmission of the first visible cloud images from space in 1959, much progress has been made through space meteorology in trying to tackle some of these problems. Rapid technological progress has permitted the extension of observations from the visible to the infra-red, ultra-violet and microwave regions of the electromagnetic spectrum and the development of a global system making complementary use of polar orbiting and geostationary satellites. The first satellites used television cameras to provide pictures of cloud patterns. The introduction of thermal infra-red scanning systems made possible the measurement of cloud data that could be used in the computer models of the atmosphere that are the basis of weather forecasting. The first operational system, based on these techniques, included the APT system which made satellite imagery freely available in real-time anywhere in the world to anyone who could build or buy a simple low-cost ground receiving system.

81. As higher resolution sensors were developed, it became possible to make meteorological observations from geostationary orbit, where the constant field of view permitted frequent observations and also enabled satellites to relay ground measurements and processed satellite data between ground stations. In particular, the raw digital image data are received by primary receiving and processing facilities which retransmit corrected and processed data in simpler formats to less expensive secondary user stations. Sequential images from geostationary satellites, acquired at intervals of typically 30 minutes, can be compared to determine wind speeds at cloud level. During FGGE (1978-1979), five geostationary meteorological satellites were in orbit to provide continuous coverage around the world. The Global Observing System within WWW now includes geostationary meteorological satellites launched by the United States (GOES) (3); Japan, GMS (2);

the ESA METEOSAT (2); and a system of polar-orbiting meteorological satellites operated by the USSR (the METEOR series) and the United States (the NIMBUS and TIROS-N series). These polar-orbiting satellites operate in the sun-synchronous orbits at altitudes of 800 to 1,500 kilometres. In the near future the Global Observing System could be augmented with the Indian and the USSR geostationary satellites. India has already launched a multi-purpose geostationary satellite which provides meteorological imagery over the Indian Ocean.

82. The use of high resolution Fourier spectrometers and multifrequency radiometers for atmospheric and mesospheric sounding in absorption bands in the infra-red and microwave regions has introduced the third dimension into satellite observations previously limited to cloud levels. These profiling sensors provide measurements of air temperature and humidity as a function of altitude, for use in computer models of the atmosphere or weather forecasting.

83. Air and water pollution monitoring is another activity made possible by new sensors. Radiometric and spectrometric measuresments with better spatial resolution or through point sounding may be able to identify specific pollutants, their concentration, drift and dispersion. Source location will be improved by high resolution remote sensing satellites. There are plans to use laser radar (Lidar) systems aboard the SPACELAB for atmospheric studies. Development of technologies and techniques of pollution monitoring should be encouraged.

84. An important direction of experimental and future operational meteorology will be the monitoring of slowly changing atmospheric variables and the implications of these changes for long-term weather patterns. Satellite sensors are being developed to measure global albedo and the amount and distribution of carbon dioxide, chlorofluorocarbons, ozone and dust. These factors are affected by man's activities and long-term changes may give rise to changes in weather patterns with harmful environmental and economic effects. Satellite sensors provide the best means of accurately monitoring such global phenomena, and the further development of such sensors should be continued.

85. Observations over the oceans, particularly of such parameters as sea-state, sea-surface temperature and precipitation, are important for meteorologists. While DCPs (see para. 87 below) can collect such data in situ, microwave radiometers, microwave scatterometers and radar altimeters on-board satellites can provide this data over large contiguous areas or long profiles. Since these techniques are yet at an experimental stage, their further development must be encouraged and scientific studies in these fields need to be intensified.

86. Many problems of environmental monitoring can only be solved by combining high temporal resolution with (selectively) high spatial resolution. To cope with these requirements within reasonable data rates, future satellite systems will emphasize flexibility of sensor parameters. Long and variable focal length optics may be used in order to get, by ground command, either "wide angle" or "high resolution" imagery; a selection of filters and sensors may provide optimum spectrometric sensitivity for different tasks. The geostationary orbit will provide a synoptic view and the possibility of frequent observations. Development of such systems that provide frequent observations and transmit the data at low bit rates should be encouraged.

87. Data from meteorological satellite sensors need to be combined with ground, air and sea-based in situ measurements if their potential for improving weather

forecasts and monitoring environmental parameters is to be fully exploited. Therefore, both geostationary and polar-orbiting meteorological satellites are increasingly being used for relaying data from manned or unmanned DCPs to central ground receiving stations which automatically decode, process and retransmit the data to specific users. DCPs consist of small automatic collectors and transmitters of data that can work without maintenance for long periods of time. They are normally installed in remote or inaccessible land areas, attached to moored or drifting buoys or ships for monitoring sea conditions and currents, or flown on balloons to measure air movements and other parameters. Geostationary GOES satellites can relay the data of up to 10,000 DCPs every 6 hours. Polar-orbiting satellites can additionally be used for determining the position of drifting buoys by means of Doppler measurements. The use of DCPs with satellite relay is restricted to low-data rate transmissions (typically 100 bits per second). Therefore, DCPs are normally used in connexion with sensors for the measurement of slowly changing parameters such as temperature, humidity, atmospheric pressure, wind speed and direction, sea state, rainfall, snow height, etc.

88. Before the advent of satellites, balloons were used for gathering meteorological data from the upper atmosphere. Today, balloons and sounding rockets continue to play an important role in collecting meteorological data. Rockets are also used for dissipation of hailstorms that could otherwise cause damage to crops. Systems for such hailstorm control are operational in some countries, including the USSR, China and Argentina. The use of such systems for other countries should be studied.

89. As data becomes available from more sophisticated meteorological satellites and as the science of meteorology advances, more accurate and longer range forecasts will be possible, although the original goal of GARP to extend the reliability of weather forecasts to two weeks seems difficult. However, the full potential of current and future meteorological satellites beyond the stage of APT and WEFAX data reception can only be exploited by means of more sophisticated (S-band) direct receiving stations and the use of large, expensive computers for data pre-processing, analysis and modelling. Few developing countries are likely to be able to afford such investments on their own. Close regional co-operation or the establishment of regional or international centres is an attractive way for developing countries to derive the benefits of these technological advances without exorbitant investments or duplication of national efforts. The feasibility of setting up such regional or international centres for meteorological data reception and analysis is being examined by WMO, and should be encouraged. On the other hand, the centralization of such facilities is a viable solution only if there exists a well developed regional communications infrastructure which allows the minimization of the data turn-around time. Otherwise the near real-time availability of this data - an indispensible precondition for its usefulness - is lost. Before embarking on the establishment of such regional centres, it should therefore be examined whether already existing telecommunication links are sufficient to transmit the analysed data to national centres or could be expanded at reasonable cost. Otherwise the local establishment of smaller and simpler, cost-effective data reception and processing stations might be the only viable solution. Another important precondition for the successful long-term use of meteorological satellites for operational weather forecasts and monitoring of climate changes is that data are acquired over extended periods of time with at least part of the basic and well proven sensor and orbit parameters fixed in order to allow statistically valid evaluations. Thus all possible efforts must be made

to maintain continuity in programmes of operational meteorological satellites, particularly with regard to their financing or any other modification that may be introduced.

90. Since forecasting or understanding of local weather requires integration of relevant data collected in many countries and over large regions, progress in this field is possible only through close co-operation between nations. The whole field of meteorology has a history of such co-operation and space meteorology has continued this tradition. The world-wide free availability of data from meteorological satellites through decentralized direct reception, and rapid world-wide data exchange is crucial for the effective use and rapid integration of satellite data with data from ground-based networks. It is desirable that such co-operation - exemplified by co-ordination of efforts and exchange of data - be not only continued, but further intensified.

### E. Remote sensing

91. Remote sensing technology with its various components can be considered as a technical imitation, modification and extension of the natural eye-brain system. Using remote sensing techniques from a high vantage point, man can extensively and systematically derive environmental information over a wider range of the electro-magnetic spectrum and with a higher, quantifiable and thus objectively reproducible, spectral and radiometric resolution.

92. Though satellite remote sensing systems are - in the formal sense - still at the experimental or pre-operational stage, many countries have made considerable investments in ground stations, processing and analysis facilities and the data is being used on a near-operational basis. This indicates a clear recognition of the importance of satellite remote sensing and its potential contribution to economic develoment; it also implies an understanding or hope that data will continue to be available. Definite indications in this regard from satellite operators are important, so that countries can continue to invest in ground equipment or devise alternative means of obtaining the data.

93. With respect to sensors used, a principal distinction has to be made between passive and active remote sensing systems. The first requires a natural supply of reflected (solar) or emitted (earth) radiation, while the latter provides the initial signal itself and records the object's response (reflection, scattering, fluorescence emission, etc.). Remote sensors can be mounted on a large variety of air or space-based platforms operating at different altitudes and for different periods of time. Consequently, satellite remote sensing should be recognized as being just one component in a complex multistage integrated systems approach, which also includes extensive sampling of ground information. The technology as well as the methodology developed for satellite remote sensing has therefore a significant bearing also on the efficiency of a purely aircraft-supported remote sensing system and vice versa.

94. From the early manned satellites with short duration missions, astronauts and cosmonauts used conventional hand-held photographic cameras to take pictures of the earth from various altitudes and at various angles. While these pictures had very limited applications, they were dramatic and showed some unexpected features, exciting speculation as to what might be done. As satellites became larger and missions longer, systematic surveys could be undertaken and special camera systems

were designed for remote sensing from space. Multispectral cameras were designed to use a variety of films and filters, allowing more flexibility in image processing for different applications.

95. A major advance was the development of automated satellites for weather and earth observations using multiband electronic sensors and real-time data transmission to the ground. These satellites made possible regular, repetitive surveys of the earth's environment and resources on a global scale. Within a few years, cheaper and more reliable linear arrays of electronically scanned detectors (charge coupled devices) are likely to replace the currently dominant electromechanical scanners. While electronic sensors tend to have poorer resolution than photographic systems and are thus less suitable for large-scale mapping, the advantage of regular coverage over many years offsets the resolution disadvantage in the case of monitoring changing phenomena. Furthermore, electronic sensors can make observations at infra-red and microwave wavelengths, beyond the sensitivity of photographic film.

96. The advantage of real-time data transmission can only fully be exploited by users if decentralized direct data reception and rapid, efficient data dissemination is guaranteed. Therefore, a growing number of countries are establishing remote sensing ground stations which generally provide data to all countries within the zone of coverge. In order to take full advantage of the real-time data transmission and to manage the vast amount of data that will inevitably flow from future remote sensing satellites, further decentralization of ground data reception and processing facilities down to national and provincial scale may be desirable. The availability of cheap and versatile technology for the ground segment as well as the ability of user countries to develop an indigenous capability for designing, establishing, maintaining, running and adapting the components of the ground segment to advances in sensor technology are important pre-conditions in this respect. At present the scarcity of foreign exchange, as well as difficulties and delays in procuring spare parts or getting maintenance services not only hamper indigenous developments but also occasionally render existing facilities inoperative for long periods. Additionally, a number of users particularly feel the need for assurances from countries operating remote sensing space segments of continuing services with direct and unrestricted access to data of their territories at reasonable prices before embarking on extensive investments in ground facilities (see also chap. II, paras. 204 and 225). A number of operators of space segments feel, however, that, if continuity is to be assured, the prices that users pay will reflect a sharing of the cost of these expensive systems.

97. In the last two decades, over 30 earth observation satellites have been launched, mostly from the United States and the USSR. Since 1972, remote sensing has become increasingly "quasi-operational" through the LANDSAT satellites of the United States. Four have been launched including LANDSAT-D which was launched in 1982. The Soyuz, Salyut, Meteor and Meteor-Priroda spacecraft of the USSR have also collected extensive remote sensing data.

98. By the end of the decade there are likely to be six or more remote sensing satellite systems operated by national or regional agencies. Apart from those of the United States and the USSR, remote sensing satellite systems are likely to be set up by Brazil, Canada, China, France, Japan, India, and possibly other countries. In addition, a remote sensing satellite system will be established by ESA. While discussions are under way to make some of these systems compatible with

existing ground stations and complementary to each other, the design of each system will correspond primarily to the requirements and capabilities of the agency concerned. The sensors on these satellites will operate at visible, infra-red and microwave wavelengths with a variety of resolutions and fields of view, thereby allowing the user to select the system or combination of systems that best meets his needs. By the end of the decade a number of satellite systems will be operational and prices for data are likely to rise to cover the costs of developing and operating the systems. A number of users have expressed the need to institute arrangements to enable them to have continued access to data at reasonable costs (see chap. II, para. 209).

99. Future satellites with data direct transmission will have higher spatial resolution and some will have pointable sensors and stereo-viewing capabilities (e.g., the SPOT system of France). Other new satellite sensors such as the thematic mapper of LANDSAT-D (United States) or the Soviet Union's FRAGMENT-2 have significantly improved spectral capabilities. All weather active sensors have already been flown - e.g., the microwave radar on SEASAT of the United States - and some future systems also include similar sensors (the United States Space Shuttle flew an imaging radar and both ESA and Canada are considering synthetic aperture radar satellites).

100. The currently dominating trend in the development of electronic satellite remote sensing systems is towards multipurpose and multichannel (up to eight) high-resolution sensor packages, sometimes including an all-weather capability (radiometer, scatterometer, altimeter and imaging radar). This results in extremely high data rates (up to about 200 megabits per second) and the use of microwave (around 8 GHz) technology for data transmission and reception. The latter requires costly augmentation of existing (2 GHz band) data reception facilities and poses significant problems with respect to data pre-processing and handling.

101. This tendency has spurred studies into possibilities of on-board data processing aimed at data compression and reduction of redundant information. However, at present no technologically viable and generally accepted solution is in sight. The optimal data compression algorithms would change from scene to scene and would depend upon the specific application area, thus reducing the usefulness (or even being detrimental) for other applications. A retransformation of compressed data into its original form would be very expensive and would entail some loss of information. Nevertheless, further research in this field is desirable.

102. On the other hand, various studies of current as well as potential applications of earth observations from space seem to indicate that satellite systems based on a total systems concept incorporating both space and ground segment and taking into account special needs and conditions of major application areas and user communities could be a viable alternative or at least a cost-effective complement to highly sophisticated, multipurpose remote sensing satellites with their immensely high data streams. Data rates between 5 and 15 Mbit have been proposed for such dedicated remote sensing satellites. One such concept for an agricultural application would allow for flexible selection of both spatial and radiometric spectral sensor parameters depending on actual user requirements. Other application areas for dedicated remote sensing satellites are geological surveys, mapping or remote sensing in tropical areas. The latter could

be achieved by, for example, launching the satellite into a high or near-equatorial orbit providing high temporal resolution in order to cope with prevailing cloud cover.

103. Besides these developments in the field of electronic sensors, high resolution panchromatic and multispectral photographic sensors with high geometric fidelity will continue to be flown on automatic as well as manned space missions. Their use will not require sophisticated technology or the establishment of costly ground segments. It will probably remain superior for large-scale mapping (down to 1:50,000 as demonstrated by the USSR Soyuz-22) of quasi-stationary or slowly changing phenomena observable in the visible and near infra-red part of the spectrum. Space photography, therefore, constitutes a valuable complement to the frequent direct reception at low data-rates of medium resolution remote sensing imagery. It is a low-cost approach with respect to data analysis and therefore is particularly attractive for developing countries which cannot afford large investments in ground hardware.

104. While this section has dealt primarily with the satellite component of a remote sensing system, it is clear that other elements on earth are equally - or even more - important. These include not only the data reception facilities, but also the data processing and analysis hardware, the computer software, equipment and techniques for "ground-truth" collection and, of course, the organizational and utilization aspects. Data processing and analysis facilities may range from large, sophisticated and expensive computers to simple, inexpensive photo-processing and visual interpretation equipment. The choice of technology and equipment depends upon a country's needs, resources and specific characteristics. However, it needs to be emphasized that a great deal can be done through simple, inexpensive equipment and appropriate techniques.

105. The systematic collection of ground truth is indispensable for the proper interpretation of remote sensing data. The creation of a data bank of representative examples of radiometric-spectral and/or structural-textural appearance of typical ground objects and feature associations in the respective types of remote sensing data ("signature bank") would be a desirable activity requiring comparatively little investment. Of course, even here there is a wide range of possibilities and costs - from ground truth radiometers to more expensive mobile platforms (e.g., "cherry pickers") that carry a wide array of equipment like spectrophotometers, scatterometers, etc. It is important to note that signatures and ground truth are area-specific and therefore countries involved in remote sensing have to carry out this work for themselves and/or on a regional basis. These aspects of ground truth, data processing and analysis need greater emphasis and it is desirable that countries devote special effort to work in these fields.

106. With the advent of operational remote sensing satellite systems and with more and more countries already establishing ground segments for data direct reception and/or data processing and analysis, great attention has to be paid by countries developing and operating space segments as to the complementarity and compatibility of their data systems with those of other satellite systems. This will help to avoid redundant experiments, to minimize costly changes of existing ground equipment, to guarantee a long-term availability of satellite data and to enable their broadest possible use with existing facilities (see also chap. II F). In this connexion, the importance of a complementary future use of geostationary orbit

for environmental remote sensing using satellites with selectively adaptable sensor parameters becomes obvious, particularly for tackling problems of monitoring and mitigating disasters.

107. Likely future developments include the continuing use, with great benefit, of photo-interpretation techniques by a large number of users, particularly in developing countries. At the same time the use of computer processing, interactive and automatic analysis and integration of interpreted information into computer data banks is likely to grow very rapidly. Data from a variety of remote sensing systems, along with meteorological, climatological and hydrological data and economic, social and demographic statistics, may be formatted to a common geographic framework. A network of terminals could allow users to obtain specialized maps compiled from these data bases according to any combination of parameters specified by the user. In general, systems are likely to become more user-oriented.

## F. Navigation, global positioning and geodesy

108. Position determination - in real time for navigation and with an acceptable delay for geosciences - is an increasingly important requirement in a wide range of human activity. It has become essential in civil engineering, environmental planning, resources exploration and management, transportation and traffic control, search and rescue operations, etc. It is also a vital tool for a deeper understanding of the internal structure and dynamics of our planet and for studying crustal movements in relation to earthquakes. These applications require accurate position determination and monitoring of position changes in space and time.

109. Before the advent of satellite technology, the classical task of geodesy, i.e., the determination of the figure and size of the earth and of the geometry of its surface, had to be solved by precise determination of the geometric connexions between single points at the earth surface as well as of the parameters of the terrestrial gravity field and by finding a suitable mathematical model which fitted these measurements best. Position measurements by means of satellites provide instead geocentric co-ordinates of surface points and thus data on the physical earth's surface without assumptions and hypotheses on the figure and the internal structure of the earth. Besides this, satellite technology has demonstrated its unique capability for high-precision geodetic measurements and navigation on a world-wide scale, covering also with the same accuracy the vast ocean areas. The synoptic view and frequent repetitive coverage of the earth surface are major advantages offered by satellites. Particularly in the case of frequently repeated precise vertical position measurements along long traverses, the costs are considerably less than those incurred using conventional methods. This, and the fact that many developing countries are not well mapped, makes geodesy an especiallly relevant and important application for developing countries. The low investment on ground equipment and the high pay-offs in terms of new information would be attractive and suitable for most countries.

110. Other important tasks of geodynamics, in particular direct measurement over large distances of plate-tectonic movements with sufficient accuracy, monitoring variations of polar motion with very high accuracy, the study of terrestrial tides and monitoring the earth's rotational period with an accuracy down to 100 micro-seconds, can only be solved by means of modern satellite and space technology.

111. Principally, observations of an orbiting satellite can be used to determine the relative positions of the observer and the satellite. If the position of the observer is known, the position of the satellite can be calculated and vice versa. Once the satellite orbit is accurately determined, an observer anywhere in the world can determine his position. For navigation, the observer wants to use simple equipment to make a quick determination of his position which may be changing quite rapidly, while for geodesy precise position determination - with fewer restrictions as to time and complexity of equipment - is required. The technologies of navigation, global positioning and geodesy are therefore very closely related and have developed in parallel.

112. Early satellite tracking was based on radio interferometry using radio beacons on the satellites. More accurate observations for checking the radio determinations and for correlating ground geodetic networks were obtained by photographing simultaneously the satellite track against the star background from several ground stations. Already these early tracking data showed that the figure of the earth is pear-shaped, departing from the theoretical assumption of a rotation ellipsoide by up to 10 or 20 metres. But these methods were not yet sufficiently accurate for geodynamic applications. To meet these precision requirements, new space geodetic techniques such as laser ranging to and from satellites, microwave interferometry using distant extraterrestrial radio sources (e.g., quasars) and satellite radar altimetry have been developed.

113. Laser ranging to satellites was originally developed to improve the precision of satellite orbit determination. Now it has become also an invaluable geodetic tool to determine station positions with an accuracy ranging from several decimetres down to 1 to 2 centimetres. The latter is currently achieved only by a few fixed stations but design goals for mobile laser stations under development are also aiming at this precision, which is required for regional crustal deformation studies and actual measuring of plate-tectonic movements. In order to achieve this high precision, special geodetic satellites have to be compact, heavy and placed in high altitude orbits in order to minimize the effects of air-drag and of gravity anomalies. Also, a very high level of technical sophistication in hardware is required which includes accurate time and frequency standards, high-power short-pulse duration lasers and wide-band recording systems. The hardware required to achieve 1 to 2 centimetres positioning accuracy over distances of hundreds and thousands of kilometres is as yet available in only a few countries and the world-wide distribution of fixed laser ranging stations is rather uneven. It is therefore desirable that wider deployment of both fixed and mobile high-performance stations take place, so that internationally co-ordinated measuring campaigns can help develop a better scientific understanding of the earth and its dynamic features.

114. Studies have shown that space-based laser ranging equipment with the passive retroflectors attached to the ground targets might be useful and cost-effective alternative system for rapidly surveying the relative positions of sites with a few tens of kilometres' spacing but spread over fairly large areas such as tectonically active regions. The development of such equipment therefore deserves to be encouraged.

115. Highly advanced computer modelling is needed in order to interpret the results of high precision laser measurements in the centimetre range taking into account the earth's gravity field, earth tides, ocean loading and the effects of earth's

precession, nutation, diurnal rotation and relativistic effects. International co-operation in this, through a pooling of data and knowledge, could greatly accelerate progress in this field.

116. Satellite laser ranging and radar altimetry have also greatly contributed to a much more detailed presentation of the earth's gravity potential up to harmonic order 36. Recently launched dedicated gravity field mapping satellites will soon allow determination of the gravity field with an accuracy of several milligals and with a spatial resolution of about 100 kilometres. This is roughly equivalent to obtaining the geoid at this resolution to an accuracy of a few decimetres. These missions have recently been supplemented by detailed mapping of the earth's magnetic field from satellite to an accuracy of a few nT (nanotesla). Besides geodetic satellites, laser ranging of the moon has also been used for studying terrestrial geodynamics, providing information on long-term changes in polar motion and the earth's rotation rate.

117. The second basic method of space geodynamics involves radio interferometry by simultaneously receiving and later cross-correlating the radio noise from distant radio sources at widely spaced antennas. Accuracies of about 4 centimetres have recently been reached over distances of several thousand kilometres. The results are obtained in an inertial reference frame. Systems planned to be operational in the next few years will provide daily estimates of polar motion and earth rotation with expected errors of about 5 to 10 centimetres in pole position and only 100 micro-seconds in time. These stations will also serve as base stations for crustal deformation measurements and plate-tectonic studies by means of mobile VLBI stations.

118. Accurate VLBI measurements require extremely precise timing. Hydrogen maser clocks have been used as the frequency standard in the most successful VLBI programmes. These clocks are expensive and not yet commercially available. Also the tape recorder requirements are very stringent. Data rates in excess of 100 megabits per second have to be recorded, which is equivalent to recording 20 television channels simultaneously. These technological difficulties in VLBI are offset by the advantage that VLBI stations can be made small and highly mobile. In order to check the validity of high precision laser ranging and VLBI measurements, both systems should be used in parallel with considerable overlap of the network of observation sites of the two types.

119. The use of satellites for navigation began early in the space age with the use of Doppler analysis of signals received from continuously radiating space-based radio beacons of high frequency stability which also regularly broadcast the satellites' orbital data. The equipment and the calculation techniques have been refined since, but the basic system is still current today. If a large number of measurements are taken over an extended period of time using more complex data processing, the results can even be sufficienty accurate for use in geodesy and geodynamics. It is therefore desirable that the computation techniques, equipment and necessary information be widely disseminated.

120. The same method - of measuring the Doppler shift - is also used for locating the position of fixed as well as mobile platforms on land and in the sea or air. These could be data collection platforms or equipment on board ships, aircraft, etc. Based on this, search and rescue systems have been devised for locating

ships, aircraft or land vehicles in distress. Demonstrations of such search and rescue systems are being planned by the USSR and co-operatively by Canada, France and the United States.

121. Both the United States and the USSR have navigation satellite systems in operation. The Tsikada low-altitude satellites of the USSR serve several hundred ships, off-shore drilling rigs and floating bases. The United States NNSS has satellites in 1,000-kilometre circular polar orbits and serves a wide variety of users from many countries. Improvements in computational techniques have reduced the position-fixing error to less than 1 metre.

122. A proposed advanced navigation satellite system, being set up by the United States and called GPS or NAVSTAR, is scheduled to be fully operational by 1986. It will comprise 18 satellites in circular 20,000-kilometre orbits, six each in three equally spaced orbital planes. This would ensure that a minimum of four satellites would always be in view of any given station, thus allowing immediate and extremely accurate three-dimensional position fixes by means of independent range and Doppler calculations. Ground receivers can be made very small and easily portable because of high signal strength.

123. Further processing of the data is expected to provide absolute positions in the 1 metre accuracy range, and considerable advances have been made towards the adopted goal of positioning by Doppler satellite to an accuracy of 10 centimetres or better.

124. Using VLBI techniques and GPS, a number of investigations have demonstrated subdecimetre three-dimensional accuracy on baselines of several hundred kilometres. These results have encouraged the development of transportable VLBI stations for possible monitoring of the small (1 to 10 cm per year) plate-tectonic movements for earthquake studies.

125. In view of the considerable scientific and practical utility for both rapid and high accuracy position location, it is desirable that world-wide access be provided to such systems.

126. Apart from navigation, space techniques provide an efficient way to improve the precision of geodetic measurements for position determination. The practical value of the extraordinary technological progress may not be immediately obvious, but what may be of interest today to geodesists alone may well, tomorrow, end up serving the needs of other disciplines, in particular those that are concerned with the management of the planet's resources and its environment.

### G. Space transportation and space platform technologies

127. It was the first launching of an artificial satellite into earth orbit by the USSR in 1957 that marked the beginning of the space age, and even today the criterion that defines a "space power" is the capability of carrying out a complete space mission, including the launch into orbit. At the same time, with the increasing importance and utility of space-based platforms, technologies related to space structures have also assumed significance.

128. As we progress to larger and larger systems in space, the demand for economy becomes paramount. If space systems using large space structures are to be

economically competitive with terrestrial systems, their costs and the costs of transporting them to low earth or geosynchronous orbits must be minimized. Specified performance at minimum cost will dictate the way in which large space systems are designed and made.

129. With respect to space transportation systems, there has been a continual increase in payload capability, improvements in the precision of propulsion and orbit control systems and an increase in the reliability of systems. The efforts to improve the performance of space vehicles have been accompanied by persistent efforts to reduce the costs of launching. The large number of missions, and the growing proportion of these missions with a more or less "commercial" character, have made economic factors increasingly important. The future development of space transportation systems will depend largely on cost considerations. These considerations do not, however, imply a standardization of space transport technology. They have, rather, produced two fundamentally different options.

130. One technology is that of reusable vehicles. The costs of such partially reusable vehicles can be spread over a large number of missions. The increased complexity, and therefore cost, of making these systems wholly or largely reusable will be offset if they can be used a sufficient number of times. The other option is expendable vehicles whose cost can be reduced through the production of a relatively large number of vehicles. It is likely that these two options will remain in competition for some time, and perhaps indefinitely, since the wide range of requirements for space missions may best be satisfied by different transportation systems.

131. Cost reduction is also sought to be achieved by the simultaneous launching by one rocket of more than one satellite. China, ESA, the USSR and the United States have demonstrated the capacity of their launch vehicles to make such multiple launches. For the launch of geostationary satellites, the geographical location of the launch pad is also an economic consideration: payload capacities are significantly greater for a launch from near the equator than for one from a high latitude.

132. The technical resources for designing, building and operating the rocket-related technologies exist in a number of countries. With the systems that are now in use, those that are about to become operational and those that are under development, users are assured of having a variety of systems available to meet their needs. This variety is important since it will contribute to unrestricted availability of space transportation services and will keep prices within a reasonable range. It also helps the user to optimize his satellite without being constrained to a single set of size, weight and launch environment limits.

133. The primary future demands will be to reduce specific transportation cost. This reduction of specific transportation cost will be achieved either through vehicle reusability, a technique which will certainly be further developed in the future, or by means of multiple launches carried out with expendable vehicles.

134. The United States Space Shuttle is the first of the reusable vehicles. Its launch mass is 2,000 tons and the payload it can carry to low earth orbit (LEO) about 30 tons. It is partially reusable: the winged "orbiter" vehicle is expected to be flown into orbit and back to earth more than 100 times, while the large propellant tank is expended each time. The solid-propellant boosters are recovered and are proposed to be reused for ten or more flights. The reduction in launch

cost is expected to be substantial. The vehicle return capability has also another important advantage: expensive payloads which are compatible with the space shuttle, such as the Space Telescope, can be returned from space back to earth, refurbished, re-equipped and launched again, thereby offering considerable potential cost savings.

135. New and ambitious space projects - made possible by advancing technology and decreased launch costs - may require very frequent launches. As applications of space technology become operational and more widespread, there is also need to provide on an assured basis, launch facilities to all countries for peaceful applications or research. It is therefore desirable that:

(a) Launching services should be provided through bilateral or multilateral arrangements, on equitable terms, to all countries wishing to use them for peaceful purposes;

(b) Development of more economical space transporation systems should be encouraged in every possible way;

(c) The long-term consequences of the increasing number of launchings should be studied; if there are harmful consequences, corrective measures should be taken.

The increased frequency of launchings might also require a certain degree of co-ordination to avoid interference between launching operations at different sites. Consideration might also have to be given in the future to regulations to minimize the environmental effects of exhaust gases or of the re-entry of burned-out lower stages. (See also chap. II H and I.)

136. While launch costs per kilogram of payload have been decreasing, future fully reusable large launch vehicles are likely to allow further reductions. These vehicles with 100-ton payload capability are technically feasible with present technology, but require a large development investment. Systems reliability and the consequent vehicle complexity require considerations of simpler vehicles with fewer stages, which also reduce operational costs. Hence SSTO vehicles have gained increased interest in recent years. Thus, future launch vehicles are likely to be distinctly different from the multistage expendable launchers which are widely used today.

137. Orbit-to-orbit or orbital transfer vehicles are of particular importance for satellites or stations to be set up in geostationary orbits. In the past, transfers from low earth to geostationary orbit have been carried out by using liquid and solid fuel rockets. While cryogenics (liquid hydrogen and liquid oxygen) would allow an increase in capabilities, other propulsion systems are also being investigated. These include high-energy, storable propellants, solar-electric, and nuclear-electric propulsion. Each has specific advantages, and the choice must depend on the particular needs.

138. With advances in space technology, it has become possible to launch large spacecraft into orbit; simultaneously, new applications have been suggested which require even larger space structures. Space operations centres, space satellite power systems, manufacturing in space: these and other concepts have arisen from the rapid development of space technology. This includes improvement in systems for tracking, telemetry and command, increasing automation, a more precise understanding of the dynamics of structures in space, increasing efficiency and

power in electrical generation systems as well as remarkable developments in the reliability of electronic and mechanical systems. These advances have been made possible by the technical advances in other fields, particularly in micro-processors. It is equally true, however, that the development of space technology has contributed to the development of these other fields through an extremely productive process of cross-fertilization. This implies that, if it is essential for a country wishing to make even a modest contribution to the development of a space system to have a minimum of industrial infrastructure, this same infrastructure will benefit from new capabilities and spin-offs resulting from participation in the space system.

139. The technical resources for designing and building space research and applications systems are developing in an even larger range of countries than is the case with space transportation systems, and this trend should be encouraged. In this field as well, economic factors are becoming more and more important. A reduction in the cost of space operations will require a reduction in the price of space systems through the development of more highly organized space industries. Economies can also be achieved by increasing the operational lifetime of space systems, thereby effectively spreading the cost over a longer period. Extended lifetimes will also serve the valuable purpose of helping to ensure continuity of operational service.

140. For large space platforms, structural aspects assume great importance - in terms of weight, size and ease of fabrication. Deployable structures have already been used for various space applications - especially for solar panels and antennas. Erectable structures permit high packaging density and are mass-limited rather than volume-limited at launch. However, erectable structures are likely to require human intervention through extra-vehicular activity in space. Automated assembly is also being studied, though, and may become possible in the future. Structures fabricated and assembled in orbit seem to hold the greatest promise for achieving low-cost structures for large systems. The development of automatic beam builder machines - capable of building structures as large as 1 kilometre or greater - for use in space is currently under way in the United States.

141. Materials for space structures are of obvious importance in terms of optimizing performance at a given cost. The basic requirements are high stiffness, low density, long life and low thermal distortion. While considerable experience exists in the use of aluminium and aluminium alloys for aerospace purposes, it does not satisfy all the requirements. Titanium, steel, magnesium, beryllium and graphite/resin composites are alternatives being considered at present.

142. Large space systems would inevitably require considerable amounts of power. The present technology of solar-cell arrays is rapidly advancing through the use of low-density honeycomb cores and low-mass face sheets that provide greater power per square metre with lower mass. Future developments may include the use of gallium-arsenide or gallium-aluminium-arsenide materials with efficiencies above 20 per cent and multiband cells (which use a larger fraction of the solar spectrum) with efficiencies around 30 per cent. High performance batteries (possibly using nickel-hydrogen) long-life fuel cells, radio-isotope generators and nuclear reactors for high power are in various stages of consideration, design and development.

143. As mentioned earlier, some possible future space systems which will require large-scale operations in space, such as assembly of large multimission space

platforms, or operation of permanent space stations, will demand new analyses of the appropriate role for man in space operations. It will probably not be possible to give a definitive or universal answer to the question of whether it will be more desirable, efficient and economical to give an important role to manned operations in space, to completely automate these activities, or to utilize some optimum combination of manned and automated subsystems.

144. The realization of programmes of great magnitude will also require renewed consideration of wide participation by the international community in these activities. The enormous complexity, size and cost of these activities must not retard the progress that has been made - even if it is still modest - in disseminating space technology to a greater number of countries. Studies should therefore be made of the implications for international co-operation of these new concepts of large-scale space systems.

## CHAPTER II

## APPLICATIONS OF SPACE SCIENCE AND TECHNOLOGY

### A. Current and potential applications of space technology

145. As is clear from the previous chapter, space technology has been developing very rapidly and its practical applications began within a few years of the launching of the first satellite - the USSR SPUTNIK - in 1957. Few other technologies have witnessed such a rapid transition from experiment to routine operation and almost no other advanced technology is as widely used. Space technology is now used in a wide variety of fields and its current applications include communications, navigation, remote sensing, meteorology, and other geo-sciences. Space manufacturing and space biology are fields in which some experimentation is already under way; space power systems have been studied and analysed in depth, and even space settlements have been discussed. Given the rate at which space technology has been advancing, there will soon be no technological constraint to the realization of these concepts. The actual application of space technology, however, has to be constrained by other considerations, such as economic, socio-economic and environmental considerations. This chapter discusses space applications from this perspective of beneficial use.

### 1. Telecommunications*

146. Of all the applications of space technology, the most widely used - and the one that has become the most routinely operational - is satellite communication. While its first uses in 1960 were for intercontinental communication, satellites are being used by a growing number of countries for domestic communication also. Satellites for international communication are operated since 1964 by INTELSAT and since 1971 by INTERSPUTNIK. (For a brief discussion see chap. III A). INTELSAT also leases capacity on its satellites for domestic services. Some countries have their own operational domestic satellite communications systems (Canada, India, Indonesia, USSR and United States), while many others have plans to set up such systems soon.

147. Thus, for some developing countries with limited investment in conventional terrestrial systems, with difficult terrain, geographical isolation or vast geographical areas, and therefore, with poor communication infrastructure and/or other difficulties against using conventional terrestrial systems, satellite communication would be a big boon: therefore, developing countries must pay particular attention to these needs.

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* The use of the expression "telecommunication" in the present report refers to communications in a general way and need not be construed to be strictly in accordance with the definition of the term as given by the International Telecommunication Union Convention of ITU.

148. Communication plays a key role in development, to the extent that it transfers information, data and ideas. It is one of the key infrastructure lements for social and economic development. While broadcasting does have greater reach and often more impact, the two-way nature of telephone and telex services engenders participation and involvement. For historical reasons, telephone and telex services are, almost everywhere, organized as a self-supporting and/or revenue-earning activity. As a result, even when rapid expansion of telephone and telex services has taken place, it has been inevitably in the heavy traffic areas. Thus, in many developing countries it is easier to make an international call rather than an intercity one, and easier to call another city in the country than a small town only a few miles away. In part, this is due to satellite communication and its distance-insensitivity, but mainly it is due to a lack of adequate resources, technical expertise and capital to establish an extensive and reliable infrastructure. It is therefore desirable that developing countries examine in detail the importance of communications, especially to and from rural areas, as an integral element of development and that studies to this end be undertaken by appropriate agencies of the United Nations system - especially ITU, which has already initiated work in this field, and UNESCO which has recently established IPDC. Due to the important role of communication, it is necessary that funding institutions recognize communication as an essential infrastructure for development and provide adequate funding for systems (national and regional) that aim at strengthening this infrastructure.

149. Despite the many advantages and the tremendous possibilities offered by satellites, their use is not necessarily always advantageous or beneficial. There are situations in which space communication may not be the best solution and may, in fact, be needlessly expensive. Even where space communication is used, an optimum mix and an integration of various systems is necessary. All countries - and developing countries in particular - should therefore undertake careful studies to determine the best approach to their communication needs. Where necessary, the United Nations system should provide assistance in the conduct of such studies.

150. Even when the use of a satellite seems optimal, it is necessary that the matching infrastructure be in place on the ground. Experience indicates that satellite capacity is often under-utilized due to poor co-ordination and planning on the ground, especially with regard to interfaces - both equipment and organizational - between the space element (including the earth stations) and the rest of the system. This aspect - equipment interfaces, appropriate modems, organizational co-ordination, etc. - therefore needs special attention.

151. Technological advances have made it possible to use small and inexpensive earth terminals. These are especially important for rural communication, where the need is generally for only a small number of circuits. The ANIK system and the design for AUSSAT provide such communication to widely separated users in areas far removed from conventional communication or power services. CCIR of ITU has for many years been studying low capacity earth stations and associated satellite systems. An ITU study financed by the Federal Republic of Germany has revealed the potential value for Africa of a satellite system specially designed for rural telecommunication and capable of using small earth stations. This is especially important when one remembers that current satellite systems are basically designed for high density traffic.

152. The African countries are at the moment exploring within the Pan-African Telecommunication Union (PATU) and the African Union for Post and

Telecommunications the possibility of establishing a regional "multi-function" satellite telecommunications system. Such a system should make it possible to:

(a) Use small earth stations;

(b) Use satellites with high EIRP concentrated in the intended receiving areas and capable of ensuring allocation on request and should also be capable of operating in the demand-access mode;

(c) On-board use of regeneration and switching systems; and

(d) Use ground terminals that are as inexpensive as possible and capable of operating from renewable power sources or standard batteries.

153. For a vast number of purposes, instantaneous two-way communication is far from essential. What is required - especially in rural areas - is a way of sending and receiving messages and data quickly, reliably, easily and economically between a number of different points. Existing systems - both conventional and space - do not cater to these needs and requirements; where they do, it is only in an inefficient, slow and/or expensive manner. It now seems feasible that fairly simple satellite-based systems may meet these needs. It is even possible that in some cases a low-orbit satellite system (involving an inexpensive launch and relatively inexpensive satellite) combined with microprocessor/computer technology could adequately satisfy these needs by serving as a "travelling electronic postman". It is therefore recommended that the United Nations, in association with appropriate specialized agencies, e.g., ITU through CCIR, and UNESCO, should make a study of the economic aspects of the use of satellites in low orbit by the developing countries.

### 2. Mobile communications

154. Mobile telecommunications are used for different purposes and new services are being considered. There is a possibility of applying space technology for land mobile and aeronautical communication, in addition to existing and future maritime communications. An integrated system might, in the long term, lead to a reduction of costs for terminals used on ships, aircraft or on land.

### 3. Land-mobile communications

155. Mobile communications systems for use on land are now being planned in some countries and are being considered by INMARSAT as well. Such systems would not only be of use for normal mobile communications, but would also be especially useful for disaster relief and emergency operations. Being basically designed for use with simple terminals which need only a few channels each, such systems could clearly be modified to serve rural communications - where the needs are somewhat similar. This possibility merits examination, and countries and agencies planning mobile communications systems using satellites should be encouraged to look at the feasibility of using the same system for rural communication in developing countries.

156. The INMARSAT Council has decided that, in the context of its research and development programme, space segment capacity would be made available for general

mobile experiments and pre-operational trials on a pre-emptible basis. Such use of the INMARSAT space segment would be without prejudice to any institutional arrangements and without commitment to provide operational services. The INMARSAT space segment can also be used for emergency relief operations on land with transportable earth stations approved and commissioned in accordance with the appropriate INMARSAT standards and procedures.

### 4. Maritime communication

157. Maritime communication is now an established space application and INMARSAT is the international agency that operates the system for international maritime communication. Maritime communication via satellite will not only result in quicker and more reliable communication, but will also lead to greater safety at sea and quicker response to emergencies. The proposed Future Global Maritime Distress and Safety System being evolved by IMO and INMARSAT would be an important contribution to safety at sea and deserves the continuing support of all nations. WMO and INMARSAT have recently initiated co-operation to find means of improving the collection and dissemination of meteorological data to and from ships using the INMARSAT system. While the present importance of maritime satellite communication is necessarily limited in most developing countries, its role is bound to grow with time as maritime developing nations expand their trading and shipping fleet and - later - their marine resources exploitation activities. However, in order to derive the full benefits of space technology for maritime communication, the efforts of INMARSAT (with ITU and IMO) to develop smaller and quite inexpensive ship terminals for a broad range of communications, distress and safety applications should be continued. Necessary changes in the over-all system design should be examined by INMARSAT, particularly from the point of view of enabling greater usage by developing countries. In this context, appropriate United Nations agencies should provide assistance, on request, for the conduct of studies aimed at assessing the communication requirements.

158. In certain circumstances, the primary requirement is for one-way communication - transmission of storm warnings or other messages - and for reception of a beacon to facilitate search and rescue missions, if required. These are vital for maritime safety, and INMARSAT is actively studying possible methods for early implementation of one-way (broadcast) transmissions of weather forecasts, storm warnings, navigational warnings and other safety messages, for reception by means of simple and inexpensive broadcast receivers suitable for all classes of ships. INMARSAT is also co-operating with ITU and IMO in an experimental programme where emergency position-indicating radio beacons (EPIRB) capable of immediate distress alerts to shore will be tested. Experiments and demonstrations will be conducted in 1982-1983 by the Federal Republic of Germany, Japan, Norway, the USSR, the United Kingdom, and the United States using INMARSAT satellites and in conjunction with shore stations operated by INMARSAT member States and ESA. In addition, Canada, France, Norway, the USSR, the United Kingdom and the United States are involved in an evaluation of the use of polar-orbiting satellites for distress alert, identification and position determination of EPIRBs transmitting from ships or survival craft, and crashed aircraft in distress using the SARSAT and COSPAS systems.

### 5. Aeronautical communication

159. While aeronautical mobile communication via satellites has been experimented with, there is as yet no operational system in this field. INMARSAT is examining the possibility of providing this service on its future spacecraft. It is possible that such a service could be operational by the end of the decade. ICAO is also engaged in studying the needs and possibilities of such a service. In view of the potential importance of improved mobile and fixed aeronautical communication - for both routine operations and safety - it is important that such studies be continued.

### 6. Satellite-to-satellite links

160. Another important emerging application in the communications field is satellite-to-satellite links. The United States Tracking and Data Relay Satellite System is the first such system that will be used, among other things, for relay of remote sensing data (from LANDSAT-D) to receiving stations. Such a system reduces the minimum number of stations required for receiving world-wide data from orbiting satellites. Such satellites could also be used for linking one communication satellite to another, thus enabling a signal to be sent around the globe without having to go through multiple earth-satellite hops. Satellite-to-satellite links would also assist in the exchange of television broadcast programmes between countries having broadcast satellite services.

### 7. Future communications applications

161. The advanced technologies mentioned above, in addition to others like beam shaping, multibeam antennas, frequency reuse, on-board satellite switching, use of higher frequencies and use of new communication techniques, will result in a continuing revolution in the field of satellite communications. Concepts like satellite clusters and large, very high-power communication satellites may be seen in the near future. Like most technological possibilities, these developments in space communication could be used in a wasteful manner of little benefit to most nations, or they could be directed so as to provide very substantial benefit to all nations. They could have considerable social and economic implications, and their beneficial uses would need appropriate organizational arrangements. It is therefore recommended that the United Nations system examine the implications and potentials of these developments, especially for developing countries.

### 8. Satellite broadcasting

162. Reception of satellite-relayed television programmes using specially augmented devices which supplement television receivers is now a well-proven application. The USSR and India have such operational systems. Other countries - including Australia, Canada, Japan, the United States and, in a joint venture, the Federal Republic of Germany and France - have carried out experiments and many are now planning operational domestic systems. This is obviously an application with tremendous possibilities, especially for education - in the broadest sense of the term - and as a means of accelerating development.

163. Operational use of the broadcasting satellite service in the 12 GHz band is likely to be introduced soon. This, together with the future utilization of the 22

GHz band (allocated in ITU Regions 2 and 3) and the 40 GHz band (world-wide) will make it possible to use receivers having parabolic antennas of the order of one meter diameter and smaller. In addition, advances in low-noise receivers have also made possible comparatively small (2.5 to 4 meter diameter antennas), low-cost systems for reception of television emissions in the 4 GHz band allocated to the fixed-satellite service. This band is widely used for the intended purpose of television networking in North America and the USSR.

164. The issues connected with the use of satellites for education are discussed in greater detail in section E below.

### 9. Remote sensing

165. Remote sensing has become an increasingly important application of space technology even though there is as yet no formally "operational" system. Many countries - including some developing countries - have been involved in either data analysis and/or data reception and analysis. While the LANDSAT satellites of the United States have been the most widely used, other countries - including the USSR, India and jointly by the USSR and Bulgaria - have also used their own and other remote sensing satellites. Data has been collected in various bands of the electro-magnetic spectrum, including visible, infra-red, and microwave; and both active and passive sensors have been used.

166. Remote sensing applications are most effective when data acquisition and analysis are carried out in a problem-oriented manner. Ideally, remote sensing data should be collected at different altitudes with varying degree of detail and, if possible, at different times and at different angles, in particular for stereoscopic purposes (multistage and multitemporal data acquisition). Satellite remote sensing data are generally no substitute for more detailed data from aerial remote sensing missions. But they are extremely useful for small-scale reconnaissance mapping of large areas for updating landuse, monitoring of changes, etc. even in medium scales. One satellite image typically covers an area that would require a photo-mosaic composed of several thousand aerial photos. The synoptic nature and frequent homogeneity of satellite remote sensing imagery is also very suitable for the delineation of large-scale homogeneous associations of features representing, e.g., certain types of land use, ground cover, drainage patterns, morphology, etc. This eases the incorporation of details recognizable in aerial remote sensing data into the regional context and allows, among other things, the cost and time-saving expansion of detailed local information from ground and aerial surveys to much larger areas.

167. With regard to analysis and interpretation of remote sensing data, one has to note that these images are instantaneous representations of the surface appearance of a vast number of different objects in their complex unity and relatedness. Discipline-specific information has to be filtered out, requiring an interdisciplinary understanding of the mutual relationship of these different forms and patterns and their radiometric-spectral appearance. Therefore, visual image analysis by an experienced photo-interpreter who is a specialist in a given field is generally superior to automatic image analysis in instances where the thrust of the interpretation effort lies in the recognition and complex evaluation of geometric-structural features and patterns. Much of this can be done by using very simple and inexpensive equipment and techniques (see chap. I, para. 104). On the other hand, the full resolution of radiometric-spectral feature contrasts, their

quantitative evaluation, statistical analysis and automatic classification require the application of digital methods of image data analysis. Digital image pre-processing aimed at feature enhancement can also be extremely useful for subsequent visual interpretation. Therefore, the use of interactive hybrid image analysis systems permits optimal man-computer "co-operation" and - depending on the specific task - fully exploits the specific advantages of both analog-visual and digital image analysis and interpretation. However, before embarking on major investments in expensive equipment - requiring also specially-trained personnel for effective utilization and maintenance - the need-condition context should be carefully analysed.

168. Satellite remote sensing has, a priori, planetary dimensions. The synoptic view and the possibility of frequent repetitive coverage of large and even inaccessible areas make, for the first time, regional and global monitoring of renewable natural resources and changing environmental phenomena technically feasible and economically attractive. The long-term future of satellite remote sensing lies, therefore, in its operational utilization for effective management of renewable resources and the monitoring of man's environment. This potential is still far from being fully exploited, partly due to the large time lag between the acquisition of data and their availability to the user. Effective application requires rapid, and preferably direct, access by countries to data of their territories. "User-friendly" satellites that can work with simple, inexpensive ground equipment would greatly facilitate this and their development needs encouragement. At the same time, sophisticated sensor systems transmitting very high data rates may need large, expensive ground reception and data processing facilities. Since most countries may not be able to afford such investments, the alternative of a network of close co-operation between the national agencies and regional facilities might be considered, possibly in conjunction with a system of distribution of the processed data to simple, low-cost user terminals.

169. High resolution satellite radars used for microwave remote sensing provide qualitatively different information from that obtained by visible and infra-red sensors. They have the additional advantage of all weather operation. This is important since one of the major obstacles for remote sensing in the optical part of the spectrum (visible and infra-red) is that cloud cover cannot be penetrated. Since about 50 per cent cloud cover is typical for most countries, developed and developing countries alike, a need for high-resolution all-weather satellite radar has repeatedly been expressed and a few countries are pursuing programmes aimed at establishing such systems within this decade. From an applications point of view, it must, however, be mentioned that both data acquisition and processing from such systems as well as the proper analysis of radar data for topographic and thematic interpretation pose significant problems. Currently planned systems will - for numerous technical and economic reasons - use only a single-frequency synthetic aperture radar. In the case of vegetation studies, however, good results would require multifrequency radar. Generally, much research is still needed in order to make efficient use of imaging radar data for thematic interpretation. Their main potential is currently still in the field of geologic-geomorphologic investigations, in particular in regions with heavy cloud cover.

170. Remote sensing has the potential to improve, rationalize, intensify and/or supplement conventional survey and resource management systems. Although much needs still to be done to fully exploit this potential, data obtained by remote sensing satellites and often unobtainable by any other means, complemented with

other collateral data and "ground truth" have already been widely applied with great success and significant benefits in many countries. While developed countries use this data mainly for change detection and updating of existing information, many developing countries still use it, in the first instance, to derive primary basic information on land cover and land use, hydrology, topography, geological structures, etc.

171. Remote sensing applications aimed at topographic and first order thematic mapping using methods of visual photo-interpretation are relatively simple to accomplish by trained interpreters and do not require major research efforts and investments in ground hardware. Their results are in most cases self-evident and can easily be combined with conventional data and integrated into existing traditional information systems or data banks. This type of application is, therefore, still dominant, in particular in developing countries.

172. New potentials of remote sensing lie in applications aimed at the solution of complex survey and monitoring tasks such as agro-meteorological crop-yield prediction, early detection of potential breeding sites of desert locust, detailed classification of land cover and land use, water and air quality monitoring, identification, classification and quantification of hydrothermally altered rock formations, reliable prediction of snow-melt run-off for a given water shed area, etc. A successful solution of such complex tasks necessitates the use of satellite remote sensing data in conjunction with extensive "ground truth" and other complementary data and information. It also requires major research efforts and, frequently, extensive use of sophisticated computer hardware and software for data analysis and quantitative modelling of the phenomena and processes. Such applications are - initial promising results notwithstanding - still in an experimental stage. This is the more so since operational data availability with the required sensor parameters and repetitivity of data collection is not yet assured by current systems. The same applies for all-weather remote sensing and marine observations. Oceanographic satellites have been so far purely experimental. Operational applications in this field are likely to take a few more years.

173. Recent analyses indicate that the largest benefits of satellite remote sensing might be expected in the areas of agriculture and forestry followed by applications for land-use planning and water resources management. But it should be kept in mind that the relative benefits which one can derive from different types of applications depend both on the technical parameters of available remote sensing systems and alternative systems as well as on the actual status of knowledge about one's country's resources, their relative abundance or economic relevance as well as on environmental and other conditions. Cost-benefit assessments of satellite remote sensing, too, make sense only with respect to the specific problems to be solved paying due regard to local conditions, needs, systems specifications, cost and timeliness of data acquisition, and available alternatives and recognizing that only part of these benefits may be quantifiable in economic terms. Each country, therefore, has to make its own unique cost-benefit assessment and decisions before embarking on large-scale remote sensing applications and major investments. In this respect, it is likely that many developing countries may have similar needs; those countries should jointly take necessary steps to study these needs and assess appropriate remote sensing systems to meet them. In this context, the United Nations system (FAO, UNESCO, UNDP and UNEP) should strengthen their programmes and encourage dialogues among member States so that interested countries could:

(a) Take steps to study these needs and assess appropriate remote sensing systems to meet them; and

(b) Engage in dialogues between users/potential users and designers/producers of satellite systems in order to determine user needs and the extent to which those needs can be met.

Furthermore, the regional commissions, with the assistance of the United Nations system, should carry out the necessary studies on the most efficient and practical ways of co-operation among the countries in their respective regions, on space activities; and, as appropriate, on mechanisms for their implementation.

174. Satellite-acquired data combined with ground observations may in future make possible accurate crop predictions, better management of forests and other renewable resources, location of mineral and hydrocarbon resources, etc., through better resolution, use of all-weather sensors and a better understanding of the science of remote sensing. A possible situation in which data are not available to the sensed State but are available for commercial and other forms of exploitation by another country has been a cause for concern to a number of countries. The sensed State shall have timely and non-discriminatory access under reasonable conditions to the primary data obtained by remote sensing from outer space which relate to its territory. It is therefore important to reach agreement on principles governing satellite remote sensing. Accordingly, the current discussions on this in COPUOS should be completed expeditiously.

### 10. Meteorology

175. Meteorology has been a major field of space application. Various international programmes organized by WMO (see chap. III) have met with considerable success and observations from space are now an integral and important part of weather reporting and forecasting. Satellites are used for the dissemination of processed meteorological data to users all over the world, and also for the collection of data from remote places or mobile platforms through data collection systems. Cloud cover pictures, vertical temperature profiles, sea surface temperatures, sea state, sea-ice, precipitation, snow-cover and a wide variety of other data are collected by a number of meteorological satellites operated by a number of countries. Data is received directly from satellites by many countries - mainly through the APT system - and indirectly through communication links by many others.

176. The present world-wide system is largely operational and includes close co-operation and co-ordination between satellite operators as well as national meteorological services. Problems of utilization of national space and ground segments, of standardization, acquisition, archiving as well as world-wide exchange of data and their application both for actual weather forecasts as well as in connexion with world-wide or regional research projects are discussed in WMO and the respective activities of States are co-ordinated in the framework of the WMO, WWW and GARP. Access to data from operational meteorological satellites is free, and because many countries have become dependent upon this system, it is necessary to ensure continuation and intensification of such services. This is especially important for developing countries which do not have independent or alternative sources for much of this data and for whom weather forecasting is directly linked to national prosperity because of their dependence upon, among other things, agriculture.

177. Until now, data from meteorological satellites have mainly been used in synoptic weather forecasting. For numerical forecasting, satellite data collected up to three hours preceding the starting point of the prediction are generally included without time correction. The large and well-equipped forecasting centres apply the so-called four-dimensional assimilation of satellite data. Satellite derived vertical temperature profiles are still - because of limitations in accuracy as compared to in situ measurements - useful only over areas where such in situ data are lacking. The methodology for operational determination of atmospheric humidity and wind fields from satellite measurements as well as the world-wide availability, quantity and quality of data on humidity cannot yet fully satisfy practical requirements for advanced numerical weather forecasts. More research and operational efforts in this direction are still required.

178. Geostationary meteorological satellites with their capability of virtually continuous observation of cloud patterns over major parts of the globe have proved to be extremely useful for early detection and tracking of severe tropical storms. The maximum wind speed and intensity of hurricanes and cyclones can be derived from a study of wind speed, the phenomenological type of the cloud spiral and its diameter as inferred from the satellite imagery. It is hoped that in the future satellite-based prediction of the severity and path of these storms might be possible up to 48 hours in advance with sufficient accuracy to facilitate preventive actions. WMO runs a special Tropical Cyclone Programme (TCP) in which the use of meteorological satellites is a key element. WMO reports regularly on the progress made in implementing the programme to the United Nations Committee on the Peaceful Uses of Outer Space.

179. Meteorological satellite imagery has also been used in experimental applications for flood prediction caused by snow melt run-off. Although the spatial resolution of meteorological satellites is relatively coarse as compared to resource satellite sensors, the estimates of snow cover, if the area is large enough, are still sufficiently good, and the advantage of much more frequent repetitive coverage offsets by far the resolution disadvantage. This is particularly important because the greatest danger of flooding exists in periods of rapid melting - and consequently snow cover change - in connexion with high insulation and surface temperature or rainfall. Both factors can be measured or at least inferred from satellite data.

180. Estimation of rainfall through monitoring of cloud patterns in both the visible and thermal infra-red range and the use of correlations between rainfall, brightness and radiation temperature of cloud tops in satellite imagery seem to hold promise for evaluating regional crop productivity, particularly for areas in which water availability is the controlling factor. During the NASA Large Area Crop Inventory Experiment (LACIE), rather good early wheat production estimates were achieved by combined use of LANDSAT remote sensing data (for acreage estimates) and data from meteorological satellites (for estimates of average monthly soil temperatures, precipitation and - in some instances - also potential evapotranspiration as a measure of plant stress). However, this was done only over areas with large fields and low crop variety. Also, other countries, such as Argentina and Brazil, are carrying out projects on crop production estimates, by using remote sensing and meteorological satellites as major source of data. FAO has carried out several regional studies using both data from meteorological and remote sensing satellites for early detection of potential breeding sites of migratory desert locust. Meteorological as well as remote sensing satellites also hold promise for monitoring desertification phenomena and both have been used in

joint regional studies by FAO, UNEP, UNESCO and WMO and as part of GEMS. In the Soviet Union, data from Meteor satellites are operationally used in conjunction with aerial surveys and ground truth collection for regular spring and fall estimates of biomass productivity and carrying capacity of large rangeland areas in Central Asia.

181. New experimental sensors of high radiometric and spectral resolution are also used in studies for large-scale air and water pollution monitoring and in experiments to determine the concentration of chlorophyll from quantitative measurements of "ocean color" in several spectral bands, but a good deal of basic research remains to be done before these applications can be used operationally. In any event, it seems clear that satellite systems will not be a substitute but rather a complement to in situ measurement of environmental pollutants in water and air. The main potential of satellites lies in monitoring the extent, movement and dispersion of large pollution plumes. For accurate detection and identification of sources and sinks, the spatial resolution of meteorological satellites is normally not sufficient. On the other hand, high resolution satellites do not generally meet the repetitivity requirements for pollution monitoring.

182. As already mentioned in chapter I, paragraph 87, meteorological satellites are also widely used in order to collect and distribute a great variety of environmental data acquired by remotely located, manned or unmanned data collection platforms (DCPs) on land, at sea or in the atmosphere. DCPs can, amongst other things, provide part of the independent meteorological in situ ground data needed for calibration/interpretation of remotely sensed data. The two types of data are complementary and should, therefore, be used jointly wherever possible. DCPs are also used to observe changes in seismic activity (event counters), to make river gauge and flow measurements and to monitor sea level changes that might be connected with earthquake-generated tsunami waves. The DCP data relay capability of meteorological satellites is playing an ever-increasing role in the establishment of satellite-based early warning systems for natural disasters. Requests for medical or other kind of help could also be relayed using DCP transmitters.

### 11. Navigation, global positioning and geodesy

183. Navigation and geodesy are important applications of space technology. Methodologies, major satellite systems, and the more scientifically oriented concepts and results of geoscientific applications have been dealt with in chapter I, section F. In the following paragraphs, emphasis will be laid on applications of navigation satellites.

184. Navigation has always been of great importance to man, and while navigational errors have sometimes led to unexpected discoveries, they have more frequently led to disaster. In the modern world, accurate navigation is becoming increasingly important not only for safety, but also for optimizing steadily growing traffic flows and minimizing fuel consumption through appropriate routing. Reliable position determination is also needed for a variety of other economic activities - e.g., off-shore oil drilling and sea-bed mining - or scientific studies related to geodesy, plate-tectonics, geodynamics, etc. While some of the scientific studies require very accurate geodetic measurements using satellite laser radar or very long baseline interferometry, almost all safety and economic activities can effectively be carried out by using satellite navigation based on Doppler measurements.

185. One proposed safety application is the experimental SARSAT (jointly by Canada, France, Norway, Sweden, the United Kingdom and the United States) and the Space System Searching for Vessels and Aircraft in Distress (COSPAS) (USSR) systems for search and rescue, which is already being used experimentally. Both use radio beacons transmitting distress signals to orbiting satellites which relay the signals to a ground station for processing. The two systems are compatible, enabling quicker and better response to distress signals. The Argos system, designed by France and the United States provides, on an operational basis, a positioning service. Other experiments will be carried out by member-administrations of ITU using the INMARSAT space segment (see para. 158). EPIRB equipment used for these tests will be capable of providing an immediate distress alert with transmission of the vessel's position to shore-based SAR authorities. In view of the importance and the humanitarian nature of these systems, it is desirable that the present co-operation be continued and efforts be made to evolve a world-wide operational search and rescue system as soon as possible.

186. Navigation satellite systems are operated by both the USSR and the United States. The Tsikada satellites of the USSR serve several hundred ships, off-shore drilling rigs and floating bases. The United States NNSS has been used by many countries for many years for both navigation and geodesy. This is now to be phased out and to be replaced by GPS (see chap. I, para. 122). This will have the capability of far greater accuracy for both position location and navigation on the ground, at sea and in the air. The system will operate at two different levels of accuracy. It is not yet clear to what extent the United States will permit access by other countries, but it is recommended that GPS be made available to users. However, a long-term answer to the needs of the many actual and potential user countries needs to be devised. A single world-wide system seems very attractive since it would ensure compatibility and yet require a much lower investment from interested countries because the space segment costs could be shared (see also section C below). In this connexion, it is noted that navigation and position determination was foreseen in the INMARSAT Convention and that INMARSAT has initiated studies to determine the technical and economic feasibility of providing an international navigation and position determination system through INMARSAT satellites.

187. Position location of "ground control points" is also useful for processing of remote sensing data. These are prominent features whose exact location is known (possibly by satellite geodesy) and which are then used for "correcting" the image to obtain high precision data products.

188. The immediate economic relevance - and overall importance - of satellite navigation and geodesy highlight the need for providing continuity and assured access to such systems by all countries. In its basic form, the ground equipment required for position-location (a georeceiver and a computer for data processing) is not very expensive or sophisticated and is within the reach of most countries. Thus, this is an application which can be taken up without great difficulty by all countries which have need for such uses. This is another reason to move ahead quickly and establish a mechanism and/or arrangements for an ongoing international satellite geodesy/navigation system.

### 12. Future applications

189. With further advances in space technology, new applications seem feasible. Among the major ones being studied at present are manufacturing or processing in space, and space power systems. The operational applications of these are probably many years away, but it is already time to examine their relevance and their implications. Their possible biological, ecological and radio-frequency interference impacts must therefore be studied and identified by ITU and other United Nations agencies with the necessary information to decide on them. Some of these issues are examined in greater depth in section I below.

## B. Choices and difficulties in the use of space technology

### 1. Choices

190. Space technology now spans a vast range of complexity from fairly common and comparatively simple APT receiving stations to extremely complicated fully-automated space probes. It also encompasses equipment whose costs range from a few hundred dollars - for a television direct reception system, for example - to many millions of dollars. The investments required to develop and produce such equipment differ by many orders of magnitude, as do the infrastructure and technical skills involved. The variety of space applications now feasible, though not as wide-ranging, is also quite substantial. It is within this almost bewildering array of possibilities that a country must make choices about what applications and which technologies it wishes to pursue. Clearly, the choices must be determined by:

(a) The needs of the country;

(b) Its priorities;

(c) The feasibility of meeting these needs and priorities through the use of space technology with due regard to other countries' needs;

(d) The financial resources, the industrial infrastructure and the technological capabilities of the country;

(e) The availability of matching scientific and application-oriented as well as managerial and decision-making infrastructure and human resources required for effective utilization of data and of the information derived therefrom;

(f) Recognition of the rights of other countries to utilize space technology at a later stage.

191. It is therefore obvious that there can be no fixed formulae of universal validity. It is equally evident that costs and benefits of space applications also will vary from situation to situation and from country to country. Thus, each choice of a space application by a country has to be unique: a decision based upon the parameters of its particular context. This requires that each country carry out studies regarding costs and benefits before deciding upon the adoption of a particular application. Such studies should take into account not merely the economic aspects, but also technical, environmental and social effects that may result from the use of space technology. Many of the developing countries may not

themselves have all the expertise necessary for such interdisciplinary studies. In this case it would be advisable to consult with other developing or developed countries which have worked on these problems and have relevant expertise, or to seek advice from appropriate United Nations bodies and agencies through established mechanisms.

192. In many cases, assistance may not be required for basic decisions regarding whether to get into a specific application; rather, it may be required for choices of systems, type of equipment and selection of the most suitable methodological approach to tackle the problem in question. The latter is a particularly important element, because it has a significant bearing on the choice of the most appropriate system or instrumentation and thus also determines other parameters such as cost, organizational set-up, degree of self-reliance, extent of indigenous participation possible, etc. The United Nations system should - on request and where possible - provide such assistance to help countries make appropriate choices.

193. In deciding upon and implementing a space application, there is a whole hierarchy of possibilities ranging from problem analysis and systems studies through fabrication of ground hardware to the development and launch of spacecraft and setting up and running an effective user-oriented ground segment with all its ramifications. The level and extent of indigenous effort undertaken by a country clearly depends on the criteria outlined in paragraph 190 above. Thus, countries at different levels of development would be in a position to undertake different magnitudes of indigenous efforts. All possibilities for mutually beneficial co-operation between different countries by undertaking complementary efforts in this respect should be fully exploited (see chap. III D for an elaboration on this).

194. Other important aspects with regard to the choices for utilizing space technology include:

(a) While the most sophisticated technology is frequently tailored for multipurpose utilization, it is not necessarily the most suitable for a given application;

(b) Practical application of space technology requires a great deal more than the mere hardware. These non-hardware elements need to be given much more attention than they usually get;

(c) The "end-links" in any application are of crucial importance and due care must be taken to set these up in good time;

(d) The existence - or use elsewhere - of space technology for a particular application does not automatically imply or prove its universal utility: in a given situation, it is quite possible that a non-space technology may be more suitable;

(e) While considering present applications of space technology, due attention should be paid to combining it with medium and long-term needs.

### 2. Difficulties

195. Most countries - and developing ones in particular - face a number of difficulties with regard to space technology and its efficient utilization. Some of the major problems are identified in the following paragraphs. On the other

hand, these very difficulties might spur innovative approaches, press for needed indigenous educational, scientific-technical, industrial and managerial efforts and thus finally contribute to increased self-reliance and socio-economic advancement. Suggestions on how to overcome some of these major difficulties will be dealt with in sections C and D.

### (a) Financial and industrial resources

196. Development, fabrication and operation of space hardware - i.e. launch vehicles and/or satellites - are large-scale ventures requiring a well-developed industrial and scientific-technical infrastructure and substantial investment in facilities and equipment that most developing countries do not have or cannot afford purely on their own. Also, most space applications include the use of fairly sophisticated equipment which - if not manufactured in the country itself - would need to be acquired from abroad. The investment proportions in ground and space hardware would very much depend on the type of application and on whether the space segment would have to be bought (inclusive of launch cost) or leased, in full or on a cost-sharing basis, or whether access to it or its data is granted free or at nominal cost.

197. Decisions to use space technology should be based on a proper "needs-conditions-alternatives" assessment, and, if possible, also be backed up by positive results of a pilot or demonstration project, thus assuring that there will be a return on this investment in terms of a significant contribution to socio-economic advancement and to the development of indigenous industrial as well as scientific-technical capabilities. However, space applications do have the potential to make significant economic contributions, and expenditures in this field should be looked upon as capital investments on which there will be a return. Thus, while financial support for such projects through bilateral or multilateral financing agencies is important, countries should themselves strive to raise internally at least part of the finances required.

### (b) Human resources

198. Development of space technology, as for any other new technology, requires a strong base of high-calibre manpower: scientists, technologists and technicians familiar either with space technology itself or with related technologies - especially electronics, computers, etc. But space technology is only a tool to a higher end. Its effective use also requires a large number of adequately trained personnel in the respective application areas and a fair number of knowledgeable people at the decision-making level who are aware of the potential contribution of space derived data, information and services to development and capable of efficiently integrating them into the decision-making process. Most developing countries lack well-trained people at all these different levels; however, almost all do have at least small nuclei which need to be identified and expanded through suitably tailored national and international efforts on training and education (see para. 212 below and A/CONF.101/BP/9). There is need for both national and international action in this field (see paras. 237-240 below and chap. III, para. 379).

199. The use of space technology in developing countries, especially in connexion with the import of equipment (see para. 200), frequently entails the need for hiring foreign expert services at considerable cost in foreign exchange. In most

cases, development agencies too insist on providing experts as part of a total aid package, although similar expertise might be available in the country itself. While the assistance of foreign experts can - in some cases - be of great help or even be necessary, it is obvious at the same time, that total reliance on such external experts discourages development of indigenous expertise in the respective fields and impedes self-reliance. Identification and maximum utilization of already existing expertise in one's own country, or in other developing countries with similar conditions, together with a systematic development of knowledge and abilities required, are important pre-conditions for effective development. External assistance can of course be useful, but a provision of experts should not be a mandatory part of any aid package provided by international agencies.

### (c) Equipment and its suitability

200. Space technology applications in developing countries generally require the import of costly equipment. This may be a major obstacle to the use of space technology, especially by developing countries facing severe balance-of-payments problems. However, it is true that imported equipment is generally more sophisticated and has a proven record. Nonetheless, some basic questions have to be asked and points to be considered in this regard:

(a) Is the sophistication really necessary to meet the particular needs? (In many cases, it will be found that it is not.)

(b) Does imported equipment, which entails the problem of spares and servicing, pose serious difficulties under the country's economic and logistic conditions?

(c) Is imported equipment suitable for the developing country's physical (temperature, dust, humidity, etc.) or cultural environment (way of operating equipment, etc.)?

(d) Although building equipment indigenously might be "risky", is it not an essential pre-condition to the development of an indigenous technological base? Since this "unproven" equipment will almost certainly not be used first by any other country, the opportunity to prove, field-test and - if necessary - improve it, must be provided by the country in which it is developed.

201. The risks in using a particular piece of unproven indigenous equipment instead of a standard foreign item have obviously to be assessed and weighed by each country and compared with the short and long-term benefits. A great deal depends on the values and development strategy of a country. However, in order for each country - however small or economically poor - to have some element of technological autonomy, it is necessary that due encouragement be provided to indigenous technological development.

### (d) Transfer of technology

202. In some cases, the difficulty in the use of indigenous capability is not so much a question of the willingness to use such capability, but rather the mechanisms of doing so. For example, the transfer of know-how from research laboratory to industry is not easy. The making of a single unit in a laboratory is quite different from fabricating it in large quantities in an industrial situation. This

is a problem of great importance to developing countries in particular, and has implications for fields other than space technology. Countries which desire to engage in the manufacture of various space hardware should, therefore, seek the advice of competent agencies concerning problems of transferring technology from the laboratory to industry and from country to country in the field of space technology. The problems of technology transfer from developed to developing countries are discussed further in section D below.

### (e) Internal co-operation and organization

203. Almost any space application requires the involvement of persons from various fields and sectors, who are inevitably affiliated with different departments, agencies, ministries, institutions or enterprises within a country. Lack of co-ordination and co-operation between these different agencies is often a major problem that hinders the application of space technology and the extraction of its full benefits. In many developing countries the lack of these managerial and organizational structures and of co-operative inputs - rather than insufficient technical manpower - is a major obstacle and bottle-neck in the use of technology to accelerate development.

### (f) Continuity, compatibility and complementarity

204. There are many developing countries which, recognizing the potential of space, would like to invest in expensive ground hardware, e.g., for the direct reception and processing of satellite remote sensing data. But a major impediment to this is the inability of some major space segment operators to assure the continuity of services. Another obstacle to broader utilization of existing systems is the fear of many developing countries, including those which have already made substantial investments in ground facilities, that rapid technical developments will force them to frequent and costly upgrading and/or modification of their ground segments in order to cope with increasing satellite sophistication or changes in data formats. Thus, there is need for assured continuity and to bring about - to the extent possible - compatibility and complementarity between various satellite systems. (This is discussed in greater detail in section F below.)

### (g) Availability of data and information

205. Doubts about continued availability of data from space sensors may deter countries without their own space segment from using space technology for various applications since they would feel vulnerable if they use such data on an operational basis. The non-availability of information with regard to various aspects of space technology and space applications is another serious obstacle to the greater utilization of space technology. Information on costs and benefits, on manpower requirements, on alternatives and new applications, etc., are often not easily or readily accessible. Important information about sources for equipment, experiences of others with the particular application or specific piece of equipment, etc., are also not easy to come by. Much of this information does exist, but its availability is not widely known or access to it is difficult. Often, it is available in a different form or is scattered in different places. A system of locating, collating and providing access to such information would be an invaluable aid to the spread of appropriate space technology - especially in developing nations, for whom information access is a serious problem.

### (h) Other difficulties

206. While many of the previous difficulties will be observed in the near term, in the medium and long term very important potential difficulties could face all countries, in particular developing countries. Necessary steps must therefore be taken which will allow all the countries to use space technologies at economically justified costs.

## C. Possibilities and mechanisms for enabling all States to benefit from space technology

207. It has repeatedly been emphasized (see introduction and para. 149) that space technology is not the solution to all problems and that - depending on the actual situation, needs and resources - conventional means might in many cases be a more suitable answer. Nevertheless, there is little doubt that space technology - in appropriate situations and if properly used - can lead to faster economic growth and quicker over-all development. If, however, it continues to be dominated by a few nations who invest in it, there is a danger that it may result in widening further the chasm between developing and developed nations. At the same time, this very stimulus of space technology has the potential to help the developing countries narrow the gap and to accelerate the process of development along paths of their choice. This, however, requires that all countries be encouraged to participate in various space applications so as to derive the fruits of space technology. All countries should take all possible steps to further such universal participation in the benefits of space technology. The following paragraphs outline alternative lines of action that could be taken by countries, as also by the United Nations and other international agencies.

208. Concrete and practical benefits of space emerge mainly from "end-to-end" applications projects. Thus, the real benefits from a remote sensing system come not merely from making and launching a satellite or collecting and receiving data; nor from processing and analysing the data. Rather, the practical benefits come only after the analysed data is given to the user and actually used by him in resource management, cartography, etc. While the earlier steps are obviously necessary and important, their novelty and glamour unfortunately often obscure the later, essential links in the chain which consequently do not get the attention they deserve. Similar examples can be given from meteorology - where the payoff can come only when the forecast actually reaches the individual farmer, for instance; or broadcasting, where it is the content of the broadcast that is as (or more) important than the technical means of transmission.

209. Thus, it is clear that countries without any "space" activity can not only derive benefits from space technology, but can actually participate in an important element of space applications - viz., the final utilization of the data. Clearly, in remote sensing this is possible only if all countries obtain the data collected over their territory at reasonable costs.

210. However, the use of such data - even analysed information - needs mechanisms and organizations in the country concerned which can ensure its proper dissemination and utilization. The experience of a number of countries has indicated that this is no easy matter; further, social, cultural and other differences make it difficult to transfer successful models, even when they do

exist. Thus, there is here a challenge for each country - whether developed or developing - to experiment, develop and evolve a model for its own situation. In order to derive fully the benefits of various space applications, countries should give priority to developing such information utilization mechanisms, appropriate to their needs and situation. Since this requires neither sophisticated technology nor large financial resources, this activity - essential for deriving the benefits of space applications - can be taken up even by small and developing nations.

211. In the context of data analysis, it is important to note that a crucial element in machine analysis is the software of computer programmes. Developing countries could consider assigning special priority to the training of computer programers and engineers. However appropriate hardware is also necessary and this may require fairly substantial investments. It is also important to note that there is concern about continued data availability (see para. 205). While assurances about continued data availability are desirable and would encourage many countries to proceed with investments and operational uses, there is also a need for easy and quick access to data through data banks with national functions, regional data banks with supply and/or support functions and international data banks with mainly support functions. In acordance with their respective national, regional or international functions, the data content of these would be differentiated with emphasis on one or more broad categories: general purpose data, specific data for didactical and other non-commercial purposes, programme and project related data and indexes to data. National data banks which form part of the national data base, would mainly incorporate general purpose data on the national territory, whereas data banks at regional and international levels would normally incorporate mainly specific, programme and project related data. With the very substantial - and rapidly increasing - volume of satellite-acquired data and the growing number of data banks of specialized or general nature, there is a growing need felt by users to have essential information concerning these data banks. This information could be obtained through a central clearing-house that can link needs with sources. It would also provide information on availability and location of satellite-acquired data in the various data banks, and information on how to have access to them. It is therefore recommended that:

(a) Data banks at national and regional levels be strengthened and expanded;

(b) Existing international satellite data banks composed of data for (non-commercial uses such as for training and project purposes) of the Remote Sensing Centre of FAO and of the Remote Sensing Unit in the United Nations Department of Technical Co-operation for Development be strengthened in so far as required to support regional and national centres;

(c) The FAO Remote Sensing Centre and regional centres for remote sensing should also continue to assist Member States in the development of remote sensing of renewable resource, including the provision of training;

(d) An information service having the function of a central clearing-house should be established (see chap. III, para. 432).

212. There is sometimes a notion that space technology is an altogether new discipline, education and training for which can be done only in new, specialized centres. In fact, space technology does not involve any "new" disciplines, but is mainly a transdisciplinary combination of well-established fields, including

physics, astronomy, chemistry, mathematics, electronics, various engineering disciplines (mechanical, structural, chemical), etc. Many developing countries do have at least some infrastructure in these fields, and can therefore - with only marginal help - develop a core of people who understand and can, in the first instance, make decisions regarding space technology and applications relevant to their country. Even if a country does not plan to embark immediately on development of space technology, it will have before it a range of choices with regard to various applications: should it have an (another) earth station for international communications; what type and from which manufacturer; should it get involved in remote sensing data processing; what meteorological information should it receive directly from satellites - and a host of other such questions will have to be decided upon. Meanwhile, it is likely to experience pressure from over-enthusiastic suppliers, vested interests of various kinds, and others. In such a situation, it is obviously essential that all countries have at least a nucleus of experts who can make knowledgeable decisions in the field of space technology. Already existing nuclei need to be identified and organized, and the necessary institutions and conditions for expanding them rapidly must be created. Where necessary the United Nations and its specialized agencies could help countries to develop this expertise by arranging fellowships for training and visits to appropriate centres (see sect. D below). In the short term, the United Nations system should utilize and improve existing mechanisms to provide - on request - advice to countries regarding choice of systems, equipment, etc.

213. The importance of trained manpower at all levels is recognized by all countries embarking on development and use of space technology (see also para. 198). Besides the need for technologists and application specialists there is also a need for developing a cadre of technical managers for the planning and speedy implementation of technological as well as application programmes. Equally important is that - with the growing role of technology - countries also induct appropriate technologists and application-oriented specialists from various disciplines into the administration or government decision-making machinery. This will certainly enable countries to make better choices and to derive greater benefits from space technology through more efficient and knowledgeable ways of integrating the results and services from space applications into the decision-making process. Popularization of space technology and its potential contribution to socio-economic advancement can help to create this broad awareness at all levels of a society. The United Nations, through its appropriate bodies, might play an important role in this respect.

214. However, adequately trained manpower is - by itself - not sufficient. The organization of this manpower into productive teams through appropriate institutional frameworks and the over-all mechanisms for co-ordination and co-operation within a country are equally important. Especially in an applications project, there is a need for considerable and close co-ordination between a wide variety of agencies. Such co-ordination has taken different forms in various situations: committees, joint management, a focal agency, etc. While the precise mechanisms of co-ordination will vary from country to country - dependent as they are on social, economic, cultural and other factors - the need for them has been clearly established. Therefore, countries embarking on the use of space technology should organize and set up interagency co-ordination mechanisms appropriate to their situation and needs. In order to facilitate this and to provide examples of alternatives, the United Nations should collect, collate and disseminate information on the mechanisms devised by various countries who have had experience

in space applications. Even prior to - or alongside - such efforts at co-ordination is the need to efficiently organize the resources (human as well as material) for planning and implementing space activities. Here again various alternatives do exist - ranging from allocation of specific space responsibilities to existing agencies to the creation of a new agency specially for space activities. Obviously, there is no unique solution applicable to all countries and all situations. However, the critical importance of a good organizational structure is now an established fact and countries planning to use space technology need to pay special attention to the organizational frameworks, appropriate to the country and task, conducive to the co-ordination and speedy implementation of efforts.

215. Developing countries span a wide range in the spectrum of technological capabilities and infrastructure. Thus, while some may limit themselves to "end-use" (e.g., information utilization - see para. 210) or to operation of an earth station for international communications, others may be in a position to do more. For example, countries with trained personnel could perform for themselves the all-important job of systems studies: carrying out studies to determine the best means (space or non-space) to meet the country's needs in specific fields, in keeping with national priorities. This work should necessarily be done by a country itself, so as not to be influenced directly or indirectly by equipment suppliers or others, except in cases where such expertise is not available. In this situation, the United Nations and its specialized agencies should assist countries (see para. 212), but the involvement of local people even in such cases is a necessity.

216. More detailed systems planning, including conceptual designs and laying down of system specifications, is a further step that must be undertaken indigenously by countries that do have such expertise. This, and the subsequent step of preparing a document for inviting bids (often referred to as a request for proposals), are crucial steps that determine the extent of competition that will take place in bidding and therefore the costs. The ability to analyse the resulting bids - in technical and managerial terms, in particular - generally requires a further level of expertise.

217. In this context, apart from the United States and the USSR, other countries either nationally or through regional co-operation, have built up or are building up a capacity in the field of space science and technology. It is desirable that these efforts be pursued in order to make it possible not only for these countries to utilize space science and technology for their own needs, but also to offer an alternative as partners for developing countries in their efforts to use space science and technology.

218. In this context, it is important to note that some developing countries not only have such expertise. Other developing countries could greatly benefit by drawing on this experience as an independent source of expertise.

219. A few developing countries now have both the human resources and the industrial infrastructure to fabricate ground hardware for space applications. This is a very important capability, because the ground segment for domestic space applications frequently needs to be tailored to the needs and the environment of the particular country. Equipment bought abroad might not only be too sophisticated and expensive but could also be less suitable than indigenous

hardware and require local adaptation. Also, with indigenous fabrication comes better maintenance, development of know-how, employment and - above all - greater self-confidence. However, as a rule, such equipment has teething troubles in the early stages and is not as sophisticated as the latest equipment available in the world market. Because of this, most developing countries tend to ignore and even discourage indigenously-developed equipment. However, it must be realized that long-term benefits from modern technology, including space technology, can accrue only when a country develops to the maximum extent its own technological capability. Developing countries should strive to build their technological capabilities to the limit of their human and infrastructural resources. Also, developing countries must adopt a pragmatic, need-based approach with regard to equipment: unnecessary sophistication and forced obsolescence must be avoided, as should an addiction to owning the "latest" equipment.

220. Sometimes, the equipment needs of developing countries may be unique. An example of this is the direct reception equipment for receiving television programmes beamed via satellite. The developed countries are focusing on development of individually-owned receivers, whereas the need of developing countries is for community reception equipment, operable on low-cost, local power-sources (preferably using renewable energy sources). In many such instances, developing countries would be well advised to first look for appropriate equipment from other developing countries. Alternatively, they may have to adapt off-the-shelf developed-country equipment.

221. Apart from the benefits mentioned, the indigenous fabrication of equipment has been found to lead, in many cases, to advantageous industrial and management spin-offs. There is, therefore, a strong case for encouraging indigenous fabrication to the maximum extent possible.

222. A handful of developing countries now have active programmes to develop space hardware. Here again there are considerable direct and indirect benefits, but the magnitude of investment and the technological base required obviously limit the number of countries that can at present embark on such programmes. However, there is scope here for joint effort - a pooling of financial, human and industrial resources - by groups of developing countries, aimed at building a base that could lead eventually to space-hardware capability. Developing countries should explore the feasibility of such co-operative effort for both space-based and ground equipment and mechanisms for implementing them. The United Nations system should encourage and provide assistance to such efforts.

223. The utility and importance of "pilot projects" that provide countries with first-hand experience and the opportunity to evaluate a particular space application has been proven and recognized. Such demonstration projects seem to be a necessary step that helps to prove the utility of an application and to evolve appropriate mechanisms of co-ordination and implementation. It also enables the operational user-agency to gain confidence in handling the technology involved. However, demonstrations of space technology require a satellite, and therefore considerable financial resources. Much of this investment would be fruitless if the country decided not to go in for the particular application or to use a different system. Therefore, developing countries are encouraged to negotiate with launching States for the use of their spacecraft on a trial basis for experimentation or demonstration. Some developed countries have already provided such services, on a bilateral basis, with considerable success, and have thereby

contributed substantially to the beneficial use of space technology by some developing countries. These promising examples should be multiplied, and more developing countries should be encouraged to determine - through first-hand experience - how best (or even whether) they should use space technology to meet their national needs and priorities. Such pilot projects are inevitably beneficial to all co-operating parties. Developed countries should continue to provide such services on equitable terms wherever feasible. Of course, in the case of meteorological and remote sensing applications, it may be sufficient - in the first instance - merely to provide access to the data. International financial agencies should provide financial support, as appropriate, for demonstration projects undertaken by developing countries.

224. In the fields of communication, meteorology and remote sensing, international organizations have played a vital role in making the benefits of space technology available to nations, particularly to the developing ones. WMO has, by its efforts, created a truly co-operative international network for meteorological purposes, benefiting all nations (see chap. III E). However, it has no space facilities of its own. Given the global nature of the environment and the crucial importance of weather forecasting to the economic well-being of nations (especially developing ones, with a very large proportion of their gross national product derived from weather-dependent agriculture), the crucial role of meteorology is obvious. While a great deal of international co-operation exists in this field, fostered by Member States through WMO, there is need to build further on this foundation, especially in view of the growing importance and demonstrated potential of space technology in this field. Some countries, however, believe existing systems under WMO are excellent and that United Nations efforts might best be directed at this stage to provide training to enable developing countries to make use of available data. All countries should continue to have free access to meteorological data. To fulfil this objective, WMO should be encouraged to ensure optimal use of space techniques, in particular in the related aspects of facilities for data reception and processing, data analysis and dissemination. In the same spirit, WMO should also envisage to undertake a study concerning the possibility to set up an international structure providing continuous availability of and access to satellite meteorological data.

225. Remote sensing by satellites is another application of great promise, and one of particular importance to developing nations. Lack of trained manpower and high costs of processing and analysis facilities have been major obstacles preventing mainly developing countries from deriving greater benefits from this technology. Agreement should be reached on principles governing satellite remote sensing. Work to this effect within COPUOS should be continued as a matter of priority, aimed at speedy agreement on such principles. Satellite operators should give assurances about continuity of data flows and provide indications about estimated lifetime pre-operational and operational systems in order to help all countries, in particular the developing countries. Compatibility of various systems and data formats is another important aspect; it is discussed in section F below.

226. Since remote sensing satellites can collect data from all countries, it is therefore possible to use shared or internationally-owned remote sensing satellites. Some suggestions for such international systems have been made. Also, on the basis of resolutions adopted by the General Assembly, a detailed study on an international satellite monitoring agency has been carried out (reference document A/AC.206/14, "Study on the implications of establishing an international satellite monitoring agency").

227. It is suggested that a study be undertaken to assess the need for and the viability of a world-wide remote sensing system. Such a study could consider various ways of providing remote sensing data - including regional, bilateral, multilateral and international arrangements - with the users bearing therefore the development, production, launching and operation costs of the satellites. Assuming that any one of these systems could provide assurance of continuity of data formats, avoid forced obsolescence of equipment, and enable the development and use of standardized data analysis software, the study should in particular indicate the comparative cost of such systems to the users vis-à-vis systems currently in operation and/or under development.

228. Satellite broadcasting is an application of special relevance to developing countries, since it can be used as a powerful tool for education. Benefits from a satellite broadcasting system for education and development can be very substantial, but the organizing of such a system requires a great deal of effort. In this field, studies have been initiated by UNESCO to find optimum solutions. This is discussed in greater detail in section E below.

229. Satellite communication is a field in which there has been a great deal of international co-operation for many years. However, intra-country communication - especially to and from rural areas - continues to be a major problem in developing countries. Satellite communications can provide a quick and efficient solution in many cases, and some developing countries do have plans for their own domestic systems.

230. Despite the low per-channel costs and the possibility of using inexpensive earth stations, the capital costs associated with the setting up of a satellite communications system are substantial. Since a large proportion of these costs is attributable to the satellite and its launch, a sharing of this between different countries would make for lower investments by each. Technology has now made it possible to build and launch large satellites, each of which could carry enough transponders to meet the telecommunications needs of a few countries. When the capacity is saturated, another satellite could be launched. Such a shared system has obvious advantages, and developing countries, in particular, could greatly benefit by joining together in the setting up of systems using a shared or common satellite(s). ARABSAT is an example of such a system and it is desirable that other groups of developing countries study the feasibility of such regional systems. INTELSAT is not optimally designed for domestic communications, but an increasing number of countries, including many in the developing world, are using it for this purpose. The feasibility and desirability of systems for rural telecommunications should be examined. It is also most desirable to examine whether such systems could become available on a non-profit basis.

231. While communications, broadcasting, remote sensing and meteorology are the major applications of space technology, there are others that can be as important in certain situations. Satellite geodesy, for example, has important applications - in cartography, seismology, etc. The related field of satellite navigation is also of growing importance to developing countries, especially those with maritime interests.

232. As noted earlier, INTELSAT provides one example of an internationally-owned space segment; similarly, INTERSPUTNIK has operated through leased space segment. More recently, the setting up of INMARSAT confirms once again the need and benefits

of international co-operation in space. These systems also provide a paradigm of a mechanism for channelling such co-operation into an operational and beneficial system.

233. Clearly, international co-operation is essential if all countries even more so the developing ones - are to derive maximum benefits from space technology. While developing countries will need assistance from developed countries and from international organizations, they can achieve a great deal on their own and by co-operating with each other also. In all this, the role of the United Nations will be of crucial importance. Some aspects of these issues are discussed in chapter III.

## D. Facilitating access, use and development of space technology

234. It is sometimes assumed that any involvement in space technology or applications requires a substantial infrastructure of very sophisticated industry and very large research laboratories, and is therefore outside the reach of developing countries. In fact, it is not so and quite a few developing countries are actively involved in a variety of space applications and also in the development of space technology. Some infrastructure is certainly required - even for only using space technology - but this is not more substantial than what exists now in many developing countries.

235. The basic requirement is, of course, human resources. What is needed is not "space technologists", but experts in various disciplines that contribute to space technology - electronics, computer science, engineering, and application specialists (meteorology, agriculture, geodesy, etc.) as well as the necessary support personnel. A country can begin to apply space technology with just some simple equipment - costing a few thousand United States dollars - data products from a remote sensing or meteorological satellite, and a few applications experts who convert the data into useful information. This data analysis itself can, of course, be taken to increasingly sophisticated (and expensive) levels, requiring large, sophisticated computers and other equipment that could cost millions of dollars. How far a country wants to go would depend upon its needs, priorities and extent of matching infrastructure to utilize the information.

236. Infrastructure and the extent of use of space technology are, thus, interdependent. Simple uses of space technology (as in data analysis) needs only minimal infrastructure - mainly for equipment maintenance and operations - while more complex uses need a bigger and more sophisticated infrastructure. At the "basic" level, the greatest need is for equipment operation and maintenance, which need mainly adequately trained technicians. Beyond this, one needs human and engineering capabilities for equipment modification, fabrication and development. These activities, in the case of equipment for terrestrial use, obviously require less infrastructure than in the case of space-worthy equipment.

237. Development of human resources is probably the single most important - and time-consuming - element of infrastructure augmentation. Though some developing countries do have a fairly good base of qualified manpower, most are deficient in this important aspect. While each country will have to decide for itself the best approach to this problem, it can be generally recommended that countries examine and modify as necessary their education system and curricula to place greater emphasis on science and technology. Also, at post-graduate level, interdisciplinary

work on areas connected with space technology and its applications must be encouraged.

238. These measures can have an impact only in the medium or long term. In the short term, it is recommended that the United Nations organize a fellowship programme through which selected graduates or post-graduates from developing countries can get in-depth, long-term exposure to space technology or applications. These fellowships - numbering at least 100 each year - may be at universities or training institutions, but should preferably include a substantial amount of on-the-job experience. It is also desirable to encourage the availability of opportunities for such exposures on other bilateral and multilateral bases, outside the United Nations system. As far as possible, the selected institutions/training centres should also be in developing nations, and carry out training programmes relevant to the needs of the concerned developing countries.

239. Simultaneously, the United Nations should support the development of appropriate training centres at regional levels, linked, whenever possible, to institutions implementing space programmes. These could be located in developing countries that have active space programmes or extensive training facilities. Necessary funding for the development of such centres should be made available through international financial institutions. These training centres should organize - with United Nations assistance if necessary - regular training courses of varying durations for different levels of trainees from developing countries. In the long term, technicians' training should be done nationally and these regional centres should become centres of excellence, partly for high-level "training", but primarily for exchange of knowledge through seminars, etc. The faculty should be international and drawn from developing countries to the extent possible.

240. As a third step, the United Nations should itself conduct - as part of its space applications programme and in association, where appropriate, with the concerned specialized agency - regular three to five-week seminars for high-level personnel concerned with space applications and space technology. These seminars should focus on the organization of technological or applications efforts and be broadly "managerial" in content. The primary purpose would be the enhancement of knowledge and skills of key leaders through exchanges of experience with others, discussions on problem areas and seminars on new and potential applications. These seminars would be in addition to the specialized training courses that are conducted (and should be expanded as necessary) by various specialized United Nations agencies.

241. Past experience indicates that there is no organized institutional framework in many of the home countries of the trainees, to ensure that the training is drawn upon to best advantage. Countries should therefore plan some organizational infrastructure when they send out people for training. In this context the training of managerial or leadership personnel through the seminars mentioned earlier assumes special importance. A minimal amount of physical infrastructure (equipment etc.) is also necessary, so that the returning trainees can practice and sharpen their skills, even if no application is immediately taken up. Countries also need to take note of the need for a "critical mass" before good work can take place. It is therefore advisable to take into account these situations in the planning of training with a view to training several people from each country in a given discipline.

242. It is clearly desirable that there should be wide access to knowledge and that steps should be taken to facilitate such access. While scientific meetings and seminars - including, in particular, those organized by IAF, COSPAR and other bodies of ICSU - play an important role in facilitating the free exchange of scientific data and findings, there is also a need to consider arrangements for transfer of technologies. In this context, the recommendations of the United Nations Conference on Science and Technology for Development (see A/CONF.81/16) on this subject are of importance and should be implemented. In keeping with this, countries should not place undue restrictions on the sale of components, subsystems or systems required for space applications.

243. While it is possible to undertake space applications on the basis of imported equipment, it is necessary that countries develop at least a minimal capacity for development of space technology. This "minimal capacity" will depend upon the extent of involvement - and proposed involvement - of the country in space. Such a base is necessary to ensure independent decision-making, to absorb and adapt technology and to promote endogenous development. It is therefore essential that developing countries organize and encourage indigenous development of capabilities, even while they may resort to import of equipment or technology in order to "buy time". Developed countries, the United Nations and international financing agencies should consider providing all possible help to developing countries in the setting up of such indigenous centres for absorption, adaptation and development of space technologies. The basic nuclei for such centres already exist in most countries, either in a university or in an existing research laboratory or institution.

244. It is a fact that in many developing countries indigenous expertise and capabilities are not given due recognition and encouragement. Developing countries should take steps to encourage and develop fully their already existing technological capabilities and take planned measures to decrease their dependence on foreign expertise. While imports of components and equipment may be necessary - even desirable, from an economic angle - countries must strive to develop their own system-design and system engineering capability. In this context, developed countries should not always provide equipment in complete-system or "package" form, but should be willing to provide individual elements. Developing countries should strive to import such separate elements instead of integrated systems so that system-design, engineering and integration can be done by each developing country according to its needs, requirements, capacity and environment.

245. In the long run, countries should consider if and how their industrial development should cover space technology. Equipment for almost any space application requires a great deal of simple mechanical/structural fabrication work which needs only a fairly rudimentary industrial infrastructure. Of course the fabrication is often to high accuracies, but even so, most of this work can be done without large investments. Developing countries could therefore begin indigenous production of space technology elements with mechanical items - e.g., fixed pointing antennas. Comparatively simple mechanical elements often account for a substantial proportion of system costs and therefore such indigenous fabrication will also result in lower outlays of scarce foreign exchange. It will also upgrade skill, quality control and reliability in the particular sector with general benefits for non-space activities also.

246. Design and production of professional electronics items - even from imported components - often need fresh investments (especially in test instruments) and new skills. However, the electronics industry in general is characterized by a high employment-to-investment ratio: a factor of vital importance to developing countries. Therefore, countries which have the capability and the nucleus of an electronics industry could consider expanding this for space needs if they are planning to get into applications like satellite broadcasting, which call for a large amount of electronics.

## E. Use of space technology for education

247. One of the important requirements for sustained growth and creating autonomous technological capabilities in developing countries is to improve the educational infrastructure. The needs go beyond educating the young, to providing a continuing source of information, knowledge and know-how to the adult population, some of which might be illiterate. Conventional methods of addressing these problems sometimes do not meet the appropriate needs of the rural population in this regard. While the use of space technology cannot provide instant solutions to these problems, it can complement conventional methods and accelerate the spread of education and improve its quality, particularly in remote rural areas.

248. Radio and television have been used as educational tools for many years. Radio has the advantages of wide reach and low cost and can be used even in unelectrified locations; despite this, and notwithstanding the fairly extensive radio coverage even in developing countries, radio has not yet been fully exploited for educational purposes. However, it does have the constraint of being only an aural medium. Television, on the other hand, can be an extremely powerful instrument for spreading education. Until recently, its use was constrained by the fact that reception of the broadcasts was possible only within about 100 kilometres of a transmitter. Thus, to broadcast television programmes to a given area, one had to set up a television station nearby, or set up a television transmitter and link it to a television studio or station. Now, however, space technology has made possible the reception of television programmes, even in very remote areas, without the need for a television station nearby or ground links. The technology of DBS has been demonstrated by Canada, Japan and the United States, and a large-scale educational television experiment using the ATS-6 satellite of the United States was carried out in India in 1975/76. Some other countries also have carried out experiments involving the reception of satellite-relayed television programmes by specially augmented television receivers. Canada now has an experimental DBS system and many countries or groups of countries are planning operational DBS systems.

249. A DBS system basically uses the principle of "complexity inversion", so that simple and inexpensive receiving equipment on the ground is made possible by a powerful and complex satellite. Obviously, such a satellite is expensive, and, therefore, the economics of a DBS system are dependent to a large degree on the number of receiving stations on the ground. There are, of course a large number of other variables - including, in particular, the frequency band used and the EIRP of a satellite - and the cost of the receiving equipment is largely determined by these. However, it seems clear that a DBS system becomes worthwhile only if it serves a fairly large number of receivers. Many systems for direct-to-home television broadcasting are being proposed and planned. Selection of an appropriate

reception mode, individual and/or community, will be determined by the specific characteristics of each country. For the developing countries, emphasis may be put more on the community mode of reception. At the same time, it would seem economically attractive and beneficial for small countries to share a satellite, especially on a regional basis. Another possibility is a satellite space segment, owned internationally or regionally, that provides direct broadcast service to countries. In both cases, there could be transponders dedicated to each particular country, or countries could share a transponder, depending upon their usage. Differing time-zones could also enable a sharing of transponders, if the use was limited to a few hours only and the countries were widely separated along the east-west direction. Such a sharing of a satellite - which could be as large as necessary, within technological limits - would also contribute to reducing the pressure on GSO. It is therefore suggested that:

(a) Countries might examine the feasibility of using DBS to aid the spread of education, including, as appropriate, the use of satellites having a lower EIRP than those normally associated with DBS;

(b) Countries could explore the possibility of sharing the space segment of a DBS system, including the possibility of using any existing/planned satellites that might be suitable;

(c) Interested countries should examine the feasibility of satellite space segment, owned internationally or regionally, for providing direct broadcast television service;

(d) The United Nations and concerned specialized agencies should encourage and provide assistance - as appropriate and if requested - for the above; and

(e) Existing organizations such as INTELSAT may choose to consider developing broadcasting satellite systems which could be used for educational purposes.

However, in any planning and provisioning of DBS, it is essential to bear in mind the need for strict compliance with the applicable plans and other regulatory provisions agreed upon within ITU.

250. It should be noted that some countries which are now planning direct broadcast satellites intend to combine this service with other telecommunications, with possible economic advantages. Other countries - or an international satellite system - could examine the cost-effectiveness of such multimission satellites.

251. Community reception will probably be - as noted earlier - the primary mode of receiving satellite television broadcasts in developing countries. Tens of thousands of receivers will be needed in each country and it is essential to reduce the cost of each installation as much as possible. Also, given the lack of rural electrification in most developing countries, it is necessary to think of power sources that are inexpensive, and preferably use renewable forms of energy rather than hydrocarbons. It is therefore desirable that strong encouragement - including financial and technical assistance, if necessary - be given to efforts aimed at developing low-cost community receivers for DBS and low-cost, preferably renewable, power sources to operate the system in unelectrified locations.

252. Since the cost of the reception system for a given coverage area is influenced by the frequency and EIRP of the satellite, it is suggested that efforts at

developing more powerful broadcasting satellites should be continued in conformity with the applicable international agreements and regulations and taking into account pertinent operational arrangements.

253. The allocation of frequency bands for the different telecommunication services involves consideration of a large number of complex issues. The current international radio regulatory framework is the outcome of international agreements reached at a series of world and regional radio conferences. In this context, there are several points to be noted. Flux density limits exist for all space telecommunication services including BSS to protect extensive terrestrial operations and the investments involved therein. Similarly, there are technical constraints also on terrestrial telecommunication services with a view to protecting space telecommunication services against interference. In agreeing on the flux density limits for the various services including BSS a variety of technical parameters have been taken into account with a view to ensuring satisfactory co-existence of all services, both space and terrestrial. In view of the foregoing no significant relaxation of flux density constraints particularly in the lower frequency bands allocated to BSS seems feasible in the foreseeable future. These constraints, however, have not in practice inhibited the development of BSS.

254. While considerations with regard to the hardware elements of a DBS are of obvious importance, the other "software" elements unfortunately tend to be neglected. Experience has, however, indicated that these aspects are crucial to the success of a DBS system for education. The main ones include:

(a) Educational system planning and integration;

(b) Organizational aspects including educational system management and co-ordination;

(c) Design and production of appropriate television programmes, relevant to the needs of the audience and in keeping with national priorities;

(d) Feedback and evaluation mechanisms, especially with regard to audience reactions and impact;

(e) Organisation of viewing arrangements and of post-programme follow-up ("utilization"), including ensuring of actual availability of recommended items, training of teachers for optimal use of the system, etc.;

(f) An efficient field maintenance system.

255. The importance of these aspects cannot be over-emphasized, especially because they have all to be taken care of indigenously: unlike the satellite or even receiving equipment, they cannot be imported nor do they exist in ready-made form. Even when similar elements do exist elsewhere (e.g., educational television programmes), they should be used - if at all - only with great caution, since their relevance, their ability to create audience-identification and their cultural effects may pose problems. Countries which plan to set up a DBS system would therefore be well-advised to devote effort and attention to these "software" aspects.

256. The community receivers that form part of a DBS system need not be used merely for one purpose - e.g., educating school children - but could fulfil many needs in diverse fields. A case in point is the SITE in India, during which the system was used for school education in the morning and for health, family planning, nutrition, agriculture, etc. in the evening. During school vacations, teacher-training and special programmes for agricultural extension workers were broadcast. Canada too has made use of a DBS for tele-health and tele-education. Thus, one could use the same system for specialized education (for teachers or agriculture/health extension workers), school education and general education of the total audience (e.g., in fields like health or nutrition). Such multipurpose use obviously increases the benefits; however, it does call for closer and greater co-ordination between various agencies - e.g., the Ministries of Health, Education and Agriculture.

257. While television is a powerful tool, it does provide only one-way communication. To overcome this limitation, experiments have been carried out using a return audio channel from the audience to the source - either via land-lines or by again using a satellite. In some experiments, a return video link has also been tried out. However, the additional cost of return audio links is high - because, in most developing countries, land-lines do not exist in remote areas - while return video links are prohibitively expensive. It does not, therefore, seem worthwhile now to provide such return links, except for very special purposes when the very substantial additional cost is justified by the resulting benefits or by the particular situation. In any case, the fact that such return links can only be originated from a few places at a time acts as another constraint. Thus, while immediate "on-line" feedback is a desirable part of the educational process, in a DBS system this is not easy, and the teacher or animator must provide the interventions and clarifications that are required.

258. The telecommunications sytems in almost all countries have seen tremendous expansion in the last few years. The introduction of satellites in the communication system will lead to an even more dramatic growth. Of late, more and more countries are considering how this large system can be used for educational purposes. While the availability of telecommunications in rural areas is as yet very meagre, it is now possible to think of extending coverage even to remote areas by the combination of a satellite and UHF/VHF transceivers. Through the use of appropriate terminal equipment, it is possible to receive and transmit voice, data, facsimile and slow-scan pictures. The educational possibilities that such a system (interactive communication system) - with two-way communication capabilities - could open up are substantial. It is therefore suggested that the United Nations, in co-operation with the appropriate specialized agencies (including, especially, UNESCO which has done much work in this field), initiate a study on the educational opportunities that emerge from satellite and related telecommunications technologies and firmly support the implementation of studies which have already been carried out and programmes which relate to the use of satellite systems for technical training and education and are of regional, sub-regional and national, especially those involving developing countries.

259. Advances in technology have given rise to a number of new products and equipment in communications. In order to meet the particular needs of a country, it is necessary to put together these various elements in a system appropriate to those needs. This system engineering, the configuration of the various elements into an integrated whole, determines to a large degree the success and benefits

that will result. It is essential that this be done by persons completely familiar with the needs, capabilities and resources of the country for which it is meant; however, in the absence of indigenous expertise, the United Nations system should, upon request, provide or arrange to provide assistance to countries to develop appropriate system configurations for using space technology for education.

## F. Compatibility and complementarity of satellite systems

260. Compatibility between different satellite systems enables users of one system to use other sytems at relatively little additional cost; to the extent that this provides additional useful data or redundancy, it increases the benefits for the user. Since a vast majority of countries use space technology to some degree, the benefits of compatibility could be truly global.

### 1. Meteorology

261. A striking example of the advantages of compatibility is provided by the world-wide meteorological satellite system. All the satellites have been designed and built primarily to meet the needs of specific countries or regions; accordingly, the characteristics and sensor package vary from system to system - sometimes even from satellite to satellite within a single system. However, in the vital area of data dissemination - where compatibility is both more feasible and desirable - the transmission frequencies have been standardized, so that the ground equipment of users can receive data from different systems. Member States, working through WMO and ITU, have brought about this very happy and mutually beneficial situation by continuing the traditionally close co-operation existing between States in the field of meteorology. As a result, WWW is now supported by the orbiting and geostationary meteorological satellites of various countries and of ESA.

262. Completely compatible data dissemination has made it possible for countries to receive APT imagery from the polar orbiting United States TIROS-N/NOAA and USSR METEOR satellites. The same format is also used for relaying processed imagery from geostationary satellites, as part of the Weather Facsimile Service. While technological advances and innovations are obviously to be encouraged, the need and importance of continuing compatibility must not be lost sight of to prevent any disruption in the continuity of data reception.

263. Complementarity of systems for meteorology involves complementarity of: (a) spatial coverage, (b) volume and content of data and (c) temporal coverage. As far as observations from GSO are concerned, there will soon be complete world-wide spatial and temporal coverage up to about 60 to 70 degrees latitude. In the case of polar-orbiting satellites - which typically provide global coverage once a day - the frequency of coverage can be increased by the use of complementary orbits. Complementarity of data depends on sensor design and close co-operation among system designers and also among designers and meteorologists should be encouraged.

264. WMO has played a very positive role in encouraging and bringing about close co-operation in the field of satellite meteorology. Specifically, WWW has proved to be an effective mechanism for promoting compatibility and complementarity among different meteorological satellites. The co-ordination on geostationary meteorological satellites is an example of successful and voluntary co-operation

among current operators of meteorological satellites, and operators should be encouraged in these efforts. WMO should continue to actively promote international co-operation in this field, encourage compatibility and complementarity among different systems and take all necessary steps to ensure continuity in data availability to all countries. This aspect should be considered in the study proposed in paragraph 224 and in the procedures outlined for access to non-real time information.

## 2. Remote sensing

265. Unlike meteorology, remote sensing is not yet at the operational stage. Though much work has been done, the systems are yet at what may be called a "pre-operational" stage. However, it is only a matter of time - and a short time - before this very important application attains a completely operational status in some countries at least. It is therefore opportune now to look at ways in which compatibility and complementarity could increase or spread wider the benefits from this important space application.

266. Compatibility between different systems would enable use of the same equipment for reception of data from more than one system and thus minimize both capital and operating costs. Further, compatibility of formats could permit the use of the same equipment for processing data received from different systems, and also possibly, use of the same software for analysis. Thus, compatibility would greatly benefit users of remote sensing data.

267. Discussions among several countries planning remote sensing satellite systems are taking place to consider measures for ensuring compatibility of future systems. Some co-ordination is already taking place among some of the satellite operators in this field. For instance, the United States and France have ensured compatibility of satellite-to-ground transmissions (using the 8 GHz band) of image data from the LANDSAT-D and SPOT satellites. This will enable reception of data from both systems with the use of a single station. ITU is also playing a role by allocating a band (8 GHz band) for transmissions by remote sensing satellites, so that the same antenna, feed and RF receiver could be used on the ground for reception of data from more than one remote sensing satellite.

268. However, aspects other than transmission frequency are also important, in terms of compatibility. These include format, annotation and data product standardization. To discuss these and issues like co-ordination of data acquisition, processing and distribution, the United States initiated some years ago meetings of a LANDSAT Ground Station Operators Working Group. Similar groups are likely to be set up by other remote sensing system operators: France, for example, has already announced that it will form a similar group of operators of SPOT ground stations. These are positive developments and co-ordination between these different groups should also be encouraged.

269. Data products are produced in various formats and classes, including quick-look photographic images; standard photographic images; standard CCTs; precision and geometrically corrected CCTs and HDDTs. Standards with regard to these could be useful but may require changes in equipment. Also, user needs vary so much that this may not be desirable. However, standard annotation on photographic images, and on standard family of formats for CCTs (as suggested by

the LANDSAT ground station operators) could be useful. The latter is adaptable to non-image data as well and can be used for interchange of data. With regard to precision-corrected CCTs, there is need for some standardization about pixel (picture element) sizes, data orientation and map projections, even though needs of users do vary a great deal. The present differences cause difficulties to users obtaining data from different ground facilities.

270. To overcome some of these problems, and particularly to facilitate the utilization of data from multiple complementary missions, efforts should be devoted to the development of CCT and film products which are platform and sensor independent in appropriate cartographic projections. These products, with subpixel geometric accuracy in multitemporal registration and in absolute geodetic control, might be offered in subscene format to meet a range of user coverage needs and in projections compatible with various geographical data bases. Ground station operators should be encouraged to undertake this effort.

271. Remote sensing missions depend upon a variety of factors, including user need, sensor technology, launch capability, ground system technology, etc. The combination of all these factors severely limits flexibility for achieving co-ordination and complementarity. While co-ordination of systems is a desirable goal, its practical feasibility is limited.

272. Given the investments already made on the ground by many countries - in the form of ground stations, processing equipment, data archival, software, etc. - the important element is continuity of data availability in a form compatible with present systems. System operators might keep this consideration in mind in the planning of future systems.

### 3. Communication

273. The need for compatibility in the field of satellite communication was obviously essential for international communication. Further co-ordination among different systems is necessary in order to avoid harmful interference. These needs have been well recognized by the international community and, through ITU, there exists an established system of co-ordination in this field. The problems with regard to GSO and the RF spectrum are being discussed in the ITU forums, and are dealt with separately in section G below.

### 4. Navigation and other services

274. The need to ensure compatibility and to co-ordinate certain other services like search-and-rescue, distress signalling, etc. are obvious and the situation regarding co-operation in these fields is encouraging. However, with regard to navigation applications, the picture is not so positive. This is an area of growing importance, and it is recommended that a study be made of the feasibility of establishing an international system with the active participation of all States.

### 5. Over-all considerations

275. While compatibility and complementarity between different systems would generally be beneficial, and therefore desirable, certain considerations need to be borne in mind. Briefly, these may be summarized as follows:

(a) It should not inhibit new ideas, innovations or advances in technology;

(b) It must not act as a hindrance to technological self-reliance;

(c) Systems must be need-based and user-oriented; desirable as it is to facilitate further system development by avoiding undue constraints, systems must nevertheless evolve within the framework of the international regulations in force;

(d) It should not result in higher costs or excessive dependence on one State by many others;

(e) For non-global systems, independence of individual systems may sometimes be advantageous.

Due consideration should be given to the requirements (a) to (e) above in the establishment of international regulations.

276. Though some of the above may seem to restrain compatibility and complementarity, these considerations need to be borne in mind in evolving a pragmatic approach towards co-operation in space, and one in which all countries have genuine opportunities to reap benefits.

## G. The geostationary satellite orbit

277. GSO is a unique natural resource of vital importance to a variety of space applications, including communications, meteorology, broadcasting, data relay from and tracking of orbital satellites, etc. It could also be used for such possible future applications as solar power satellites. Though not depletable, GSO is a limited natural resource. Therefore, as with any limited resource, its optimal utilization requires co-ordination, planning and/or arrangements.

278. Utilization of GSO cannot be considered in isolation: the associated issues of use of the RF spectrum and the probability of physical collision must be simultaneously looked at. The RF spectrum is also - like GSO - a limited (in practice) though non-depleting resource. While in theory it does extend indefinitely, practical constraints limit its present use to a comparatively small band. Hence, its optimal use also requires planning and/or arrangements.

279. It is in the light of this that the members of ITU have been making concerted efforts to evolve systems for planning and regulating the use of the GSO and the RF spectrum since 1963. It is noted that the forthcoming ITU Conferences in 1985 and 1987, which will continue this process in the light of technical progress and in the light of the broad considerations outlined here, will decide, in accordance with resolutions 2 and 3 of WARC 1979, which space services and frequency bands should be planned and evolve actual plans as determined to be necessary.

280. Recent years have seen the explosive growth in the use of GSO, especially for communication satellites. To the extent that this signifies increasing use of space technology for beneficial purposes, it is to be welcomed. However, while GSO is occupied largely by developed countries' satellites and international systems (see sect. III A), there are countries which have not yet placed satellites in GSO; and increasing concerns have been expressed that these positions may not be

available when they desire to use them, and that assignments in certain frequency bands (e.g., 4 or 6 GHz) may become more difficult to obtain in future due to congestion. While there now seems to be general awareness of this concern, and certain regulations have been adopted, the present system of registration and co-ordination may need to be improved to guarantee, in practice, for all countries, equitable access to the geostationary satellite orbit and the frequency bands allocated to space services. In this regard, it may be noted that WARC 1979 resolution 2 states that "the registration with the IFRB of frequency assignments for space radio-communication services and their use should not provide any permanent priority for any individual country or groups of countries and should not create an obstacle to the establishment of space systems by other countries".

281. Despite lack of agreement on defining the precise boundary between air space and outer space, it is accepted by most nations that GSO is a part of outer space and, as such, it is available for use by all States, in accordance with the Outer Space Treaty of 1967. However, the equatorial countries consider that GSO constitutes a physical phenomenon related to the reality of our planet in that its existence depends exclusively on its relation to gravitational phenomena generated by the earth, and that for this reason it should not be included in the concept of outer space and its utilization should be regulated under a sui generis régime. The International Telecommunication Convention states that GSO and RF spectrum must be used efficiently and economically so that countries or groups of countries may have equitable access to both in conformity with the provisions of the Radio Regulations according to their needs and the technical facilities at their disposal. Given the limited nature of the resource, efficiency of use is certainly important and any plan and/or other arrangement that is formulated must encourage greater efficiency. However, efficiency of GSO and RF spectrum usage should not be a barrier to attempts at technological self-reliance, consistent with the provisions of international regulations. A leading role in the promotion of more efficient use will no doubt be taken by countries with advanced space technology; and the positive efforts of the developed countries to increase efficiency should be supported and continued. It is desirable for all users of the geostationary orbit to keep in view the advantages of adopting, wherever practicable, newer technologies which could in practice facilitate more effective use of the geostationary orbit. The improvements in the utilization of GSO that would arise from the use of new technologies should permit all countries to have access to space technology at a level of sophistication appropriate to their needs, requirements and capabilities. It should be noted that there is already a positive trend toward the utilization of new technology, and this should be continued.

282. Efficiency of use cannot be an end in itself: it is only a means of ensuring all countries equitable access to this scarce resource. In particular, there are many developing countries which do not now have either the resources or the need to use GSO but are likely to do so in the future. Any planning method and/or arrangement that is evolved should recognize and accommodate the future needs of developing countries and should not result in unnecessarily hastening their plans to the detriment of their financial and self-reliance interests.

283. GSO is getting increasingly crowded with objects that have outlived their utility. While the danger of collision or physical damage by these objects to active satellites is yet small, this is a problem that is likely to become more serious in future. Therefore, ITU should examine the feasibility of incorporating in its future regulations a stipulation that a satellite owner is responsible for removing its satellites from GSO when they are no longer usable to be able to have spare satellites in the orbit.

284. In noting the phenomenal growth in the use of GSO - especially for communication satellites - and the consequent usage of RF spectrum, it may become necessary for each country or international organization to examine whether all the satellites it is operating are really required. Increasing numbers of satellites are being used for various purposes by different countries. To the extent that these systems use national resources, it is the concern of the country involved. However, these systems use increasing amounts of a limited resource that is for use by all States. It is therefore desirable that Member States, within the ITU, continue to evolve some criteria for the most equitable and efficient usage of GSO and the RF spectrum and to develop planning methods and/or arrangements that are based on the genuine needs, both present and future, identified by each country. Clearly, such a planning method should take into account the specific needs of the developing countries, as well as the special geographical situation of particular countries.

285. For certain purposes and locations, it may not be essential to use GSO. Since increasing concerns have been expressed regarding the congestion of GSO, countries should also examine whether for their needs they could use a satellite in elliptical orbit rather than in GSO. Similarly, the feasibility and over-all advantages of using elliptical orbits for international communication merit re-examination.

286. Lower launch costs and advances in other areas of space technology have now made it possible to conceive of a very large variety of possible systems including large space platforms in GSO. A single such platform could be designed to meet simultaneously the needs of a number of countries. However, it is not yet clear that such a concept will offer the flexibility required by the varying and special needs of these countries, lead to lower cost for each of them and help improve use of GSO and the RF spectrum. In order to demonstrate the possibility of this concept, it would be useful for those countries that are interested to evolve a broad design for such large platforms. In this context, it should be mentioned that improvements in the use of GSO could also be achieved by using both ground and satellite-based narrow-beam antennas. The planning method and/or arrangements developed by ITU should be flexible enough to permit the introduction of new types of systems taking into account the needs and requirements of all countries.

287. It needs to be noted that the development efforts undertaken by the technologically advanced nations have resulted in new techniques that contribute to more efficient use of GSO and of the RF spectrum. These efforts must be encouraged and continued, for success in this could effectively increase the capacity of GSO and thereby alleviate possible pressures on its use. New developments in the field of fibre-optic technology are also likely to contribute positively, by directing high-capacity traffic on transcontinental and transoceanic routes to fibre-optic systems.

288. In conclusion, considering the long-term implications of the growing activities in GSO, any solution on the use of GSO should be both equitable and flexible and take into consideration the economic, technical and legal aspects.

## H. The nature and protection of the near-earth environment

289. The rapid advances in space technology have led to a considerable increase in the extent and type of applications, as well as to greater use of space for

scientific research in a variety of fields. The resulting increase in the number of both space objects and launches is, however, not an unmixed blessing. One facet of this problem is the vast number of space objects - estimated to be in the thousands - now orbiting the earth. A majority of these are now "space debris": dead satellites, spent rocket motors, nuts and bolts, etc. While the probability of accidental collision with a "live" space object is yet statistically small, it does exist and the continuation of present practices ensures that this probability will increase to unacceptable levels. To minimize such an eventuality, the international community should, on the basis of more detailed studies, agree to appropriate measures, such as designating certain orbits as "disposal orbits", removing from orbit all inactive satellites, minimizing space debris or even organizing scavenging missions.

290. A more serious facet of the problem concerning the near-earth environment is the possible danger associated with environmental modifications caused by space activity. Pollution and reactions resulting from rocket launches are a cause for increasing concern: even though the number of launches per year has remained more or less the same from 1965, bigger and bigger rockets are being used. Also, many of the effects could be cumulative. Although no major and continuing ill effects have yet been detected, substantial and sometimes serious regional disturbances - affecting radio propagation, for example - have been documented, especially when large thrusters were ignited at higher altitudes. Effects on radio communication have also been observed due to re-entry of large objects. Such problems could assume serious proportions if very large launch vehicles - of the type proposed for the construction of an SPS, for example - were to be used on a frequent basis.

291. The disturbances in the ionosphere due to the release of gases by rockets is a problem that is under study, but which is not completely understood yet. The depletion of the ozone layer due to space activities, though not serious yet, could also become a problem with many implications.

292. Certain scientific experiments involve the release of chemically reactive substances - for example, metal vapours - into space. These are undoubtedly important tools for research, but such activities could also result in unintentional changes causing a deterioration in the natural environment. They could affect the electron density, cause plasma depletion and create a "hole" in the ionosphere. Some experiments to intentionally create such holes are planned, and will probably produce scientific insights that cannot be obtained from laboratory experiments. However, the excessive release of materials in space can be risky, and caution is called for, in particular at high altitudes even though environmental impact studies have, to date, indicated no serious long-term consequences.

293. Use of ion engines for propulsion seems to be a promising development, and some scenarios of large-scale construction in space call for the use of powerful ion engines for transfers from low altitude to GSO. However, the deposition of argon in the magnetosphere due to powerful ion engines could produce strong and long-lasting distortions in the outer environment of the earth. While a number of environmental impact studies have been performed to assess this problem, the time delay for natural recovery is yet an open issue, as are other uncertainties.

294. While the benefits of large numbers of launches and of various scientific experiments may not be available to all countries equally, many of the potential risks of these activities can be truly global. For the guidance of all States, the United Nations - in particular, UNEP - should encourage the continuation and expansion of ongoing studies by groups of independent experts to:

(a) Study the deleterious effects of intentionally releasing gaseous or other material in space for scientific studies and recommend limits on such releases;

(b) Collate existing findings and - if necessary - undertake further studies to determine the effect of rocket launches, particularly of frequent and large-rocket launches, with the aim of recommending desirable limits on size, frequency or fuels from the point of view of minimizing ill effects on the global environment;

(c) Evaluate the effects of using ion engines for propulsion and suggest means of minimizing the distortions caused in the outer environment of the earth due to their use.

295. Electromagnetic waves in space are also an issue that could cause concern. Some controlled experiments in producing electromagnetic waves in space have been carried out and no serious consequences have been detected. There is also the large radiation of energy into space from radio transmitters used on earth for a variety of uses, including powerful radars, and from power distribution lines. While the effects of these have been detected, their magnitude is yet debated and it seems likely that larger effects may be produced in future. In particular, radio transmitters on board satellites - essentially in HF and VHF bands - can generate electric and magnetic fields at large distances from the satellite, and their sidelobes can cause disturbances to other satellites. ITU is considering this problem with regard to the present range of applications. However, if and when SPSs are in service, this problem will become rather serious, due to the enormous energy flux involved.

296. For certain space applications, the use of nuclear power sources (NPS) presents advantages. However, the use of NPS may entail risks that concern all States. The issue of the use of NPS is at present under discussion in the two sub-committees of COPUOS in the context of examining the use of nuclear power sources in outer space and the possibility of supplementing the norms of international law relative to the use of such power sources in outer space.

297. The biologial risks to mankind from space activities have been examined. These include the risks of:

(a) Terrestrial micro-organisms contaminating other planets;

(b) Extra-terrestrial micro-organisms contaminating the earth;

(c) Space environment causing dangerous mutations of terrestrial micro-organisms.

Continuing studies should keep these risks in mind.

298. Astronomy - especially infra-red and radio astronomy - is in danger of being affected by space activities. SPS and exhaust gases from rockets could be a hindrance to infra-red astronomy, while the increasing electromagnetic radiations from satellites can cause interference with radio astronomy. CCIR of ITU is looking into the latter question and working towards ensuring co-operation between radio astronomers and satellite designers. Large numbers of small satellites, or large space structures like SPS, could also cause interference to radio astronomy due to spurious emissions and also as passive reflectors. However, it should be

noted that space activities have contributed very positively and substantially to the growth of astronomy, not just indirectly through better instruments etc., but very directly by providing platforms in space for telescopes, away from the "noise" of Earth. The Einstein Observatory and the planned Space Telescope are examples of this very substantial contribution.

299. Apart from radio emissions, certain other terrestrial activities are likely to cause irreparable damage to the earth's environment unless checked in time. A major concern is the use of CFCs for various purposes, possibly resulting in the depletion of the ozone layer. While the effects of this are being studied, existing research already indicates some depletion in the protective ozone layer with possible health and biological hazards to human, plant and aquatic life due to increased ultra-violet radiation. Within the framework of UNEP, the risks of such depletion have led to a decision by UNEP (EC-9) to start work on a global framework convention for the protection of the ozone layer. An ad hoc legal and technical expert group has recently initiated its work on this matter. The function of monitoring ozone depletion is therefore of obvious importance, and space technology - through satellite and rocket-borne sensors - is contributing substantially in this. A well maintained, regularly calibrated ground network is also of great importance and efforts must be undertaken to increase the quality and spatial spread of observations. In this context, the research being undertaken by various countries - with the co-ordination and assistance of WMO and UNEP - should be encouraged. Specifically, an integrated global ozone observing system should be created, under the aegis of WMO and UNEP (as recommended by the UNEP Co-ordinating Committee on the Ozone Layer).

300. While space activities have given rise to some concern about their effects on the environment, they have also contributed very substantially to the monitoring of these - and other - effects. Environmental monitoring satellites will contribute increasingly to providing information about pollution on Earth as well as in its immediate environment. However, action on this information has to be instituted in good time, especially because of the cumulative - and sometimes irreversible - resulting effects. Since such changes affect all mankind, the international community must together take action as required. Such world-wide monitoring of the earth's environment and necessary remedial action should be co-ordinated by UNEP which is already undertaking, within the framework of its Global Environment Monitoring System (GEMS), various activities in this field. All countries should promptly provide all relevant data required for such monitoring purposes to UNEP.

## I. Implications of projected developments in space technology

[illegible] next quarter century is likely to see a growth in space technology and appl[illegible] surpassing even the phenomenal progress of the last 25 years. These advances [illegible] promise of great benefits for mankind; unfortunately, however, some of the [illegible] developments could also pose serious hazards. Also depending upon how many o[illegible]lications are organized, they could lead to a skewed distribution of bene[illegible]ween countries - accentuating, thereby, the existing inequities in the world [illegible] scene. However, appropriate and co-operative actions by States - individu[illegible] acting in concert - could lead to a happier situation of more widely shared [illegible] Even if this is not completely possible, an understanding of the technical, e[illegible] social, environmental and legal implications of likely future developme[illegible]ld help in achieving this desired goal.

### 1. Space solar power systems

302. Among the major new applications of space technology, probably none has drawn as much attention as proposals for a space solar power system (SPS). This visionary concept, first put forth in the United States, may be particularly relevant in the context of growing world-wide energy needs and dwindling conventional resources (oil, coal, wood). Though its actual realization would involve efforts and finances far surpassing any that man has yet undertaken, this is not an impossible task, nor do there seem to be any technological obstacles that could not be surmounted in the next two decades or so, if the effort is undertaken. However, there are some doubts about the economics of such a venture, and it is unlikely to be worth while unless there are some major technological breakthroughs.

303. Even though SPS is unlikely to be a reality before the end of this century, it is well to keep in mind the implications that it could have. The effects on the environment due to frequent launches of the very large rockets required for the construction of such a system could be a cause for concern (see sect. H above). Should microwaves be considered for power transmission, their biological and ecological effects may also be a cause for concern because of the lack of precise knowledge about the effects - especially the long-term effects - on living organisms and in particular on man; and their potential effects on the ionosphere also warrant further studies. Interference with radar and communications systems could, however, be a problem if microwave transmission is used, due to the very large power of the SPS transmitter, which would produce RF noise almost all over the spectrum. A concerted research and technology development effort would be required to resolve some of these problems.

304. As mentioned earlier, the economics and advantages of SPS relative to other methods of energy production is by no means yet established. However, if - and when - technological breakthroughs should change this situation, and provided that the previously mentioned implications are solved to the satisfaction of all countries that may be affected, SPS would be an ideal project for co-operative international effort: its magnitude, technological challenges, financial and material requirements, its potential benefits, and its vulnerability would make international efforts not only worth while, but probably also necessary. The feasibility of undertaking a joint international effort should therefore be examined and - as a corollary - the means of sharing internationally the benefits that result. While the SPS may yet be in the distant future, it is advisable to initiate such efforts now, so as to try and evolve a harmonious mechanism for international participation and co-operation.

### 2. Space manufacturing

305. The technologies applicable to space manufacturing are discussed at length in paragraphs 48 to 54 and paragraph 61 in chapter I.

306. With regard to the use of extra-terrestrial material for space processing, or for use on Earth, note should be taken of the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (this Agreement is not yet in force).

307. The special environment of space is also being used to carry out scientific studies with regard to metallurgy, fluid dynamics, chemical reactions, etc., and also for various biological experiments. Co-operation and exchange and dissemination of scientific results in these fields should be encouraged.

### 3. Communications and remote sensing

308. Future developments in certain existing applications - particularly communications, broadcasting and remote sensing - hold out great promise but also have the potential to cause serious problems. In broadcasting, for example, the development of very powerful satellites will soon make it possible to broadcast radio or television programmes directly to home receivers. This could be a tremendous means of spreading education and disseminating information, especially in developing countries which now have very poor means of communication. Nevertheless, broadcasting via satellites could also have negative effects in certain fields and could affect the sovereign rights of States.

309. COPUOS has examined these issues at length and in great depth. It is now time for countries to agree on the legal implications of remote sensing of the earth from space and on principles governing the use of artificial earth satellites for international direct television broadcasting.

### 4. Search for extra-terrestrial intelligence

310. SETI is a technical undertaking with profound philosophical implications. Since this is so basic an issue we should use part of our resources for this quest, which is of relevance to all mankind. It should therefore be considered a joint international effort, with each country contributing whatever it can.

### 5. Space settlements

311. For the more distant future, certain scientists have proposed the setting up of settlements in space - either in orbiting space stations or on celestial bodies. These concepts have given rise to many technical studies and, in fact, there now exist fairly detailed conceptual visions for such settlements. Some research and studies have, for example, been carried out on self-sustaining systems and concepts based on recycling. While there is little likelihood - and less immediate need - of such space settlements in the next few decades, this may yet be an idea meriting continuing study, especially if materials processing in space or SPS become realities.

### 6. Conclusion

312. The rapid advances in space technology continue to give rise to romantic visions of new worlds, new frontiers and new possibilities. While these are generally beneficial, many of them have side-effects which are of concern to all nations. Also, some of the new developments could have negative social and economic implications, especially for developing and non-space nations. Thus, while advances in space technology are to be generally welcomed, their implications

need careful consideration and dissemination so as to catalyse appropriate international action. Since many developing nations do not always have the technical expertise to assess these implications for themselves, the United Nations - in association with concerned specialized agencies - should organise periodically such studies to examine all the global implications - technical, social, economic, environmental and legal - of new space developments, especially for developing countries. However, studies on matters within the competence of a specialized agency should be carried out by that agency.

## CHAPTER III

## INTERNATIONAL CO-OPERATION AND THE ROLE OF THE UNITED NATIONS

### A. Multilateral co-operation

313. Co-operation between nations on matters concerning space has a long and rather fruitful record, though recent trends leading to the extension of the arms race into outer space are a cause of great concern to the international community. It is hoped that space does not become a new arena for rivalry between nations - not only for the sake of continuing peace, but also as a stimulus to development. There are few fields of human endeavour where the need for co-operation is more essential and the pay-off greater. In fact, it is the recognition of this necessity and benefit that has led to such very successful examples of co-operation as the operational international communication and meteorological data systems. Space activities have shown a way of how different countries, with widely varying political systems, levels of development, and culture can work together for mutual benefit.

#### 1. International Telecomunications Satellite Organization

314. An example of multilateral intergovernmental co-operation is the INTELSAT system. Established in 1964 - within a few years of the dawn of the space age and very soon after the feasibility of geostationary communication satellites was first demonstrated - this organization has seen phenomenal growth. Begun by 11 nations, it now has 106 countries as members and serves over 130 countries and territories. INTELSAT operates on a commercial basis. In all its organs, each member State has one vote, except in its Board of Governors, in which votes are in proportion to the investment of each State; this, in turn, is based on the capacity-utilization of the system by each signatory. While the satellites and associated facilities are owned by INTELSAT, the earth stations and links are owned by individual countries. At present, INTELSAT has 13 satellites in orbit, and over 325 earth stations are using them. Full-time telephone circuits have grown from 75 in 1965 when the system began operation, to over 25,000 in 1981. At the same time, despite continuing world-wide inflation, the space segment charge for full-time voice circuits has been reduced from $US 64,000 per year in 1965 to $US 9,360 in 1981. INTELSAT also leases capacity for domestic use, and some countries are using INTELSAT satellites for intra-country communication; many others are planning to do so. INTELSAT will also lease four (and possibly more) maritime communications satellite subsystems to INMARSAT (see paras. 337 to 343 below).

315. In 1978, the INTELSAT Assistance and Development Programme was established to help achieve more effective utilization of INTELSAT facilities. The assistance is normally provided on a free-of-charge basis, generally on a first-come, first-served basis. Where the assistance requested would require more than two man-months of effort or extensive outside consultant services, the request would be considered on the basis of a cost-reimbursement contract or, alternatively, would be presented to the Board of Governors for approval.

316. Apart from the important role it has played in international communication and the stimulus it is trying to provide to domestic satellite communication through

leased capacity, INTELSAT has been instrumental in the rapid advancement of space technology, both through its own work and by placement of development contracts. In placing contracts, it has also attempted to involve industries from several countries - though success in this has necessarily been limited because of the technological and infrastructural constraints in most countries.

317. INTELSAT has established formal links with several international organizations and is in the process of forging additional formal links with others. It also submits annual reports to the United Nations and to the concerned specialized agencies.

318. It is interesting to note that a majority of the INTELSAT members and users are the developing nations, and to this extent INTELSAT has helped to spread the benefit of space technology to developing nations. It is also likely that no single nation would have felt the need for such a world-wide system - it would, in any case be very expensive. What has made it necessary and worthwhile is the participation of a large number of nations.

319. Similarly, there are other applications of space technology that may not be so attractive for individual countries, but would be very beneficial if nations got together and co-operated. In this regard, the organizational structure of INTELSAT, which provides, in particular, for the participation of both governmental and non-governmental entities, may merit close study as one possible model for other such ventures.

### 2. Programme on International Co-operation in the Study and Peaceful Utilization of Outer Space (INTERCOSMOS programme)

320. A programme of co-operation amongst socialist countries in the peaceful exploration and use of outer space was proposed by the USSR in 1965. Following an understanding on this proposal, a programme of multilateral co-operation was adopted in 1967 and, in 1970, given the name INTERCOSMOS. In 1976, as a consolidation of their favourable experience, the nine countries then participating in the programme signed an intergovernmental "Agreement on Co-operation in the Peaceful Exploration and Use of Outer Space". The Agreement is open to accession by other countries interested in co-operating in the investigation of space, subject to the consent of the contracting parties. In 1979, a tenth country acceded to the Agreement.

321. The INTERCOSMOS programme embraces joint activities in the following basic areas:

(a) Study of physical properties of outer space;

(b) Space meteorology;

(c) Space biology and medicine;

(d) Space communication;

(e) Study of the natural environment by remote sensing.

322. Co-operation in the INTERCOSMOS programme is conducted in the form of joint development of scientific instruments and service systems and in their integration

into satellites, other space vehicles and research and meteorological rockets, and also in the form of joint research, experiment-design, development of methodology, and joint analysis of data. One of the features of INTERCOSMOS co-operation is the absence of a common budget which would restrict the scope of joint work in space research. Every country finances the development of scientific instruments and the implementation of experiments in which it is interested. The Soviet Union provides to its partners in co-operation the facilities of space rocket technology and ensures the launching of space vehicles. Scientific results of joint experiments form a common asset of all parties to the work done and are accessible to the international scientific community.

323. From October 1969 to December 1981, 22 INTERCOSMOS satellites, 10 high-altitude research rockets and a large number of meteorological rockets have been launched for various studies. In addition, instruments developed within the framework of the INTERCOSMOS programme have been mounted on a number of space vehicles launched by the USSR as part of its national programme.

324. As an important part of the INTERCOSMOS programme, international crews have worked on-board Soviet spaceships - Soyuz and Salyut-6 - and from March 1978 to May 1981, nine international space crews have been orbited. During these flights, international crews carried out about 150 experiments in the fields of space biology and medicine, materials science, space and atmospheric sciences and remote sensing of the surface of the earth.

325. The INTERCOSMOS programme demonstrates the feasibility of countries at different levels of economic and technological development co-operating in space activities.

### 3. International System and Organization of Space Communications

326. Work in the field of space communications as part of the INTERCOSMOS programme led to the creation in 1971 of INTERSPUTNIK. It was created to meet the need for exchange of radio and television programmes, telephone and telegraph links and other types of information between different countries. Currently, INTERSPUTNIK has 14 members. Any State that shares the goals and principles of INTERSPUTNIK activities and assumes the obligations under the Agreement may become a member. INTERSPUTNIK works on a commercial basis, and on the principle of one country - one vote.

327. INTERSPUTNIK currently operates using Soviet satellites on a lease basis. All earth stations are nationally owned. Two STATSIONAR satellites in geostationary orbit are being used and 14 ground stations in 13 countries operate as part of the system; more earth stations in other countries are also planned. In addition to members of the organization, other countries also use channels of the INTERSPUTNIK system.

328. The INTERSPUTNIK system is used mainly for exchange of television programmes, in which more than 20 countries participate. About the same number use its channels for international telephone and telegraph links.

329. INTERSPUTNIK has concluded agreements with various international organizations and with INTERCOSMOS participants, identifying specific areas and forms of co-operation. It also co-ordinates its activities with ITU and other international organizations regarding frequency spectrum, standards, etc.

## 4. European Space Agency

330. ESA was established in 1975, combining the activities previously embodied in two other European organizations, set up for developing scientific satellites (ESRO) and launch vehicles (ELDO). This intergovernmental organization has as its purpose the promotion, for exclusively peaceful purposes, of co-operation among European States in space research, technology and applications. The Agency has 11 member States, two associate member States and a special co-operation agreement with a non-European State.

331. The ESA budget is financed by its member States, with contributions for mandatory activities (including the general budget and the scientific programmes) based on national incomes, whilst contributions to optional programmes are negotiated for each such programme. The bulk of the contributions are paid out by ESA to European aerospace industries, with the industrial work being shared in a manner commensurate with the financial contributions of each member State. This helps to attain one of the goals of ESA: improving the competitiveness of European industry.

332. The ESA programme includes scientific satellites, applications satellites for communication, meteorology and remote sensing, and space transportation systems development - culminating now in the development and successful launchings of Ariane. The programme also includes SPACELAB (to be launched by the United States Space Shuttle), which will enable European astronauts to carry out research in space. Several of the Agency's programmes involve close co-operation with NASA, including especially the SPACELAB and Space Telescope programmes.

333. The scientific programme includes study of the earth's environment and also of celestial objects. The application programme includes both earth observation and communication. The former includes METEOSAT (Europe's contribution to WWW and GARP), SIRIO-2 (for meteorological data distribution and clock-synchronization by means of laser techniques) and remote sensing involving a network of data reception and dissemination stations (EARTHNET), remote sensing payloads on SPACELAB and satellite systems for ocean-observation and land-related applications.

334. The communications programme led to the development of the OTS satellite and its launch in 1978 following the Symphonie satellite (a joint venture by the Federal Republic of Germany and France) and the Italian SIRIO satellites. The next generation will be ECS, five of which will be supplied to EUTELSAT. A derivation of the ECS - called MARECS - provides maritime communication; the first two satellites of this series are being leased to INMARSAT. In the area of broadcasting, the L-SAT programme aims - among other things - at providing a direct-to-home television capability, so that television broadcasts can be received using a 1-metre-diameter antenna and a converter adaptable to conventional television receivers.

335. Development of the Ariane launcher has been a major programme of ESA and its successful flights have now established its capability and operational availability. A programme for further development of Ariane, to double its payload capacity, is already under way.

336. ESA is an example of regional pooling of resources to achieve objectives and develop capabilities that are beyond the reach of individual nations. While the member States are all developed countries with substantial technological and

industrial infrastructures, the basic principle of pooling resources to achieve otherwise unattainable objectives could also be adopted by groups of developing countries. In the framework of interregional co-operation, ESA gives assistance to several regional and national entities outside its member States, in particular by training specialists in various fields of space science and technology relevant to the activities of those entities. In these activities ESA is collaborating closely with the European Communities.

### 5. International Maritime Satellite Telecommunications Organization

337. In November 1973, the Assembly of IMCO decided to convene an international conference to consider the establishment of an international maritime satellite system. Accordingly, an International Conference on the Establishment of an International Maritime Satellite System was convened in April 1975. After three sessions, the Conference adopted in September 1976 the following two instruments:

(a) Convention on the International Maritime Satellite Organization (INMARSAT);

(b) Operating Agreement on INMARSAT.

338. The main purpose of INMARSAT is to make provision for the space segment necessary for improving maritime communications; it shall act exclusively for peaceful purposes. INMARSAT is open to all States for membership. In addition, ships of non-members may use the space segment on conditions determined by the organization. By January 1982, 37 States had become parties to the Convention, and others are in the process of joining.

339. INMARSAT is financed by the contributions of its signatories, each in proportion to its investment share, which is intended to reflect the actual utilization of the INMARSAT system. It provides services such as transmission of distress messages, distribution of urgency and safety messages, public correspondence by telex and telephony, and data transmission. Later, after appropriate agreements and co-ordination with other international agencies and technical developments, it wll provide other services such as safety advisory messages, navigation and automatic warning of navigational hazards, etc. The International Conference on the Establishment of INMARSAT also recommended a study on the use by INMARSAT of multipurpose satellites providing both maritime and aeronautical services. Studies aimed at integrating land-mobile services are also proceeding in INMARSAT. In adopting the INMARSAT Convention, Governments envisaged that there would be a need for a satellite navigation system and provided accordingly in defining the purposes of the organization.

340. The organizational structure of INMARSAT, which is similar to that of INTELSAT, comprises three organs: the Assembly, in which all member States are represented and have equal votes; the Council, a smaller body of 22 signatories, with the voting power of each being equivalent to their investment share; and the Directorate, which is the executive organ.

341. While INMARSAT provides the space segment - the satellites and related tracking, telemetry, command and control facilities - ship owners are responsible for the shipborne stations. The coast earth stations and landline connexions are the responsibility of the countries concerned. Five coast earth stations were in

operation by July 1982, and another 5 are under construction, to be operating by the end of 1982, and 12 more are planned to be in use by 1984. By July 1982, about 1,350 vessels were equipped with shipborne terminals. This number is growing rapidly, so much so that all initial forecasts are now regarded as having been too conservative. INMARSAT began operation in February 1982, using satellite capability leased from the United States (MARISAT), ESA (MARECS) and INTELSAT.

342. INMARSAT works in close co-operation with a number of international organizations, including the United Nations, ITU, IMO, WMO, INTELSAT and ESA. In particular, it has established and is maintaining co-ordination and consultations with IMO on the development of the Future Global Maritime Distress and Safety System.

343. INMARSAT provides another example of co-operation in space and the benefits that result. It has the unique feature of combining public service (safety and distress messages) with a revenue-earning objective. It also provides a model of an organizational structure and a financial mechanism for such international ventures. (For further details regarding INMARSAT, see A/CONF.101/BP/IGO/2.)

### 6. Arab Satellite Communications Organization

344. ARABSAT was founded in April 1976 by the countries of the Arab League. It has 21 States as members and its headquarters is located in Riyadh, Saudi Arabia. The main objective of ARABSAT is to establish, operate and maintain a telecommunication system for the Arab region. It will complement the terrestrial network for routing regional telecommunication traffic and provide new possibilities for television programme exchange between Arab countries. The system will be equipped to provide:

(a) Regional and domestic telephony, telegraphy, telex and data transmission;

(b) Regional and domestic television;

(c) Community television.

345. The space segment will include two satellites in geostationary orbit and a third one as a spare. The control centre will be at Riyadh. It is planned to bring the system into use by 1984. (For other details regarding ARABSAT, see A/CONF.101/BP/IGO/4.)

346. ARABSAT is the first such co-operative venture by developing countries and is aimed specifically at providing the operational benefits of space technology to its member States. Not only does this co-operation result in sharing costs - thereby increasing the economic attractiveness of the system for each country - but it will also result in developing closer links and greater understanding amongst its member States. Other developing countries may like to study the system closely from the point of view of determining the feasibility of similar co-operation in their region.

### 7. African Remote Sensing Council

347. The establishment of ARSC was decided by an intergovernmental meeting (Nairobi, 1976) and approved by the ECA Conference of Ministers (Kinshasa, 1977)

which adopted resolution 313 (XIII) calling for the adhesion of all OAU member States. The Council is a co-operative body established by an international treaty and is entrusted with the harmonization of remote sensing policies within the continent and promotion of such activities in the spirit of technical co-operation among member States.

348. To date, the Council has held four conferences of plenipotentiaries and the membership rose from its initial signatories of 10 in 1979 to 22 in 1982. It is noteworthy that the Secretariat of the Council has now started its activities at its headquarters in Bamako, Mali, and that the Training and User Assistance Centres in remote sensing and their Management Committees are effectively operational. Also gratifying to note is the successful completion of the feasibility studies of two of the planned three ground receiving stations.

### 8. European Telecommunications Satellite Organization

349. The Interim EUTELSAT is a European organization created in June 1977 by a number of European telecommunications administrations in order to establish and operate space segments of European satellite telecommunication systems. It has at present 20 members. The primary objective is the construction, establishment, operation and maintenance of a European space segment for regional or domestic fixed services such as telephony, telex and data transmission as well as sound radio or television transmissions. The first generation of these satellites will be procured and launched by ESA and placed in orbit as from 1982. A definitive European telecommunications satellite organization based on an intergovernmental treaty will replace the present Interim EUTELSAT organization as soon as the international convention adopted in Paris on 14 May 1982 enters into force.

### 9. Other multilateral co-operation

350. Besides the organizations described in the preceding paragraphs, a great deal of multilateral co-operation takes place through other bodies or through special arrangements. There exist, for example, regional broadcasting and telecommunications bodies, remote sensing councils, etc. which provide for a for multilateral co-operation. There are also efforts under way to establish regional space agencies, and some regional remote sensing centres already exist. In addition, a great deal of multilateral co-operation takes place around specific programmes. Examples of this include the LANDSAT Ground Stations Operators Working Group and a similar group to be set up for SPOT; discussions on compatibility and complementarity of satellite systems between various satellite operators; co-operation with regard to scientific missions - e.g., the proposed European, Japanese and Soviet missions to Haley's comet - and applications programmes - e.g., the search and rescue system involving Canada, France, the Soviet Union and the United States. Such co-operation has proven to be extremely useful and has led to better scientific understanding of various phenomena at a lower cost. This tradition of co-operation in scientific ventures has, of course, been long-standing and is particularly exemplified by such programmes as the International Geophysical Year, the International Quiet Sun Year, GARP, MONEX, etc. It is desirable - and even necessary - that such extensive and ongoing co-operation now take place in the field of applications also. Not only would this provide benefits to all countries - developing and developed - but would also create greater understanding between nations and a better international climate.

351. Non-governmental bodies such as COSPAR of ICSU and IAF have also played important roles in encouraging and organizing scientific meetings, dissemination of scientific data, etc. (For an elaboration of their role, see A/CONF.101/BP/12.) Both COSPAR and IAF enjoy observer status with COPUOS and have been commissioned from time to time to carry out studies and prepare reports for its consideration. They provide an extremely useful mechanism by which expertise from many countries can be tapped and international teams of experts can be assigned to prepare reports or conduct studies. The special character and effectiveness of these non-governmental scientific organizations depends upon their widespread membership. In view of this and their positive contribution, it is desirable that all countries might support the participation of their scientists and relevant institutions in these organizations.

352. Space is the common environment of all mankind. Our well-being and very survival depends upon the state of the environment. Studying it, understanding it, monitoring and maintaining the delicate balance between its various constituent elements, are all necessary activities that are of global interest. Weather forecasting, monitoring of pollution, ensuring safety at sea, enabling people to see and talk to each other, the fact that combination of two separate scientific observations is greater than the sum of the parts - all these dictate the need for making space an arena of international co-operation.

353. It is urgent to encourage countries to set up appropriate regional mechanisms designed to achieve international co-operation among them for the purpose of joint preparation, implementation and financing of space technology, research and application projects. The United Nations should promote initiatives aimed at establishing regional mechanisms and should encourage its regional economic bodies to carry out studies that will facilitate their establishment

## B. Bilateral co-operation

354. Bilateral co-operation between countries in the field of space is widespread and has had very successful results. It constitutes a major segment of international co-operation in the peaceful uses of outer space. A partial list of activities fostered through such co-operation includes:

(a) The provision of a launch for satellites;

(b) The "loan" of an orbiting satellite or of part of its capacity;

(c) The loan of ground equipment;

(d) Providing sounding rockets for scientific experiments;

(e) Providing tracking support for spacecraft;

(f) Permitting the reception of data;

(g) Exchanging or providing scientific and other data;

(h) Providing training facilities;

(i) Providing advice and consultancy;

(j) Joint planning, development and manufacturing of space systems;

(k) Integrating payloads/experiments of one country in the other country's satellites/space vehicles;

(l) Rendezvous of space vehicles;

(m) Complementary space missions;

(n) Joint flights by cosmonauts from two countries on space stations of one of these countries.

355. The above list - merely representative and not exhaustive - is indicative of the very wide range of bilateral co-operation that has and continues to take place in the field of space. Such co-operation extends from basic science to operational applications; it includes co-operation between developed countries, and between developed and developing countries. For example, the United States has entered into more than 1,000 bilateral agreements with over 100 countries, both developing and developed. However, as there has been little or no bilateral co-operation between developing countries, it will be necessary to structure appropriate mechanisms for co-operation between them. There is both need and scope for this and, in view of its importance, this aspect is discussed in greater detail in a separate section (see sect. D below).

356. Bilateral co-operation between nations with advanced capabilities in space technology and some developing nations has had very beneficial results. It has often begun the processes of space technology development and application in some developing countries and has, in many cases, led to demonstration or experimental projects in space applications and science. Such demonstration projects have been of great importance for the adoption of various space applications in developing countries.

357. Some developed countries have also provided training opportunities to scientists, engineers and technicians from developing countries in space science and technology, and also in related fields. This training and work experience has often been instrumental in developing a core of experts who have been the backbone of their country's space programme.

358. Bilateral co-operation between developed countries has also been very productive. It has enabled a pooling of skills and a sharing of costs, to mutual advantage. It has resulted in development of new technologies and systems, and to this extent such co-operation has benefited developing countries also.

359. The extent and examples of bilateral co-operation are so very numerous that they cannot be summarized easily in a report of this type. While some details of such co-operation are outlined in the national papers of various countries, it may suffice to note here that almost every country participating in any form of space activity has been involved in co-operation with others in one way or another. It is important that such co-operation not only continue, but be intensified.

## C. An assessment of multilateral and bilateral co-operation

360. An over-all assessment of multilateral and bilateral co-operation in space - described briefly in sections A and B above - indicates a rather positive picture and many concrete achievements. Nevertheless, it seems clear that the full potential of the exciting possibilities opened up by space technology has not yet been tapped. More extensive co-operation, and more co-operative projects aimed at specific problems, are necessary. Greater benefits from space can be derived by intensifying international co-operation, and in this the technologically-advanced nations have a special responsibility.

361. Co-operation in space could cover a wide range of activities including the following, some of which are already being carried out:

(a) Setting up and operating regionally- or internationally-owned systems or promoting continued co-operation among satellite operators in areas such as communications, remote sensing, meteorology, navigation, geodesy, etc.;

(b) Creation of mechanisms for assuring international availability of space-derived data in fields such as meteorology, remote sensing, navigation, geodesy, etc.;

(c) Co-ordination of national, regional and international systems so as to prevent interference, especially in communications and broadcasting;

(d) Co-ordination between programmes and systems so as to maximize benefits by making systems compatible with each other and complementary to the extent possible, especially for meteorology and remote sensing;

(e) Joint planning of scientific missions and general dissemination of scientific data to all countries;

(f) Provision of opportunities and facilities by space-nations to all other nations, so that the benefits of space technology are available to all. This could include the integration of experiments/payloads in spacecraft or rockets, launch of satellites, loan of satellite capabilities for experimentation/demonstration, etc.;

(g) Provision of learning and educational opportunities; joint development and sharing/transfer of technology; exchange of experiences and specific data, etc.;

(h) Assistance in the creation of necessary infrastructure for space as appropriate for each country;

(i) Further development of international space law concerning the use of space technology and its peaceful applications.

362. While some of these activities may seem rather ambitious, international co-operation has already resulted in the significant progress of some. For example, there have existed for some time operational systems for international communication (INTELSAT and INTERSPUTNIK), and co-ordination with regard to the geostationary orbit, including use of the RF spectrum, is taken care of through ITU. In the field of meteorology, WMO has evolved an international co-operative programme of satellite observation and data dissemination, and - at the

recommendation of COPUOS - two centres for remote sensing have been set up in the United Nations system (in FAO and in the Department of Technical Co-operation for Development). COPUOS has initiated a number of treaties, agreements and/or conventions, most of which are now in force. Similarly, there exist examples of co-operation that meet some of the goals listed under each of the items mentioned above. In order for the benefits of space technology to be fully exploited and particularly to be more widely available to the mutual advantage of all nations, more work is required. In certain areas - e.g., remote sensing - there is an urgent need for achieving greater co-ordination.

363. While the benefits from space technology can be substantial, the investment called for is sometimes large and often beyond the means of a single nation. Therefore, in order to maximize benefits from space, it is necessary to devise ways of sharing the large investment costs. This is particularly so in regard to developing countries. The feasibility of this approach has been demonstrated at the international level by INTELSAT, INTERSPUTNIK and INMARSAT and at the regional level by ARABSAT, ARSC, EUTELSAT and ESA. Multilateral, regional and bilateral co-operation could result in similar systems in other fields - allowing countries to utilize space technology without themselves making very large investments. These possibilities are promising and merit further study, as has been recommended in paragraphs 224, 227 and 230 of chapter II.

364. However, paucity of funds is not the only constraint inhibiting developing countries from greater utilization of space technology. Two other major - and related - limitations are the shortage of adequately trained manpower and a lack of industrial and research infrastructure. While the major efforts in these fields have obviously to be undertaken by the country concerned, co-operation with other countries can do a great deal to accelerate progress in these areas. Existing co-operative arrangements have undoubtedly provided some help to many countries. However, it is clear that these efforts need to be intensified in the face of a problem of such magnitude. As discussed, intensive co-operation and exchange of experience between countries is an essential element in developing adequate technological capability - both human and material - in each country. The experiences may be particularly meaningful and relevant if it takes place between two developing nations, rather than from a developed to a developing one. Such exchanges between developing countries must, therefore, be encouraged. In view of the importance and potential of co-operation between developing countries, this issue is discussed in greater detail in a separate section.

365. Though a start has been made in many regions, the extent and depth of regional co-operation in space is yet rather meagre. ESA and INTERCOSMOS provide the only examples of organized, ongoing multilateral co-operation between groups of countries in the field of development and application of space technology, while ARABSAT and EUTELSAT provide examples of regional co-operation for the establishment of an operational system. There is some present and proposed regional co-operation among other groups of countries (e.g., ARSC, regional remote sensing centres, proposals for the African Satellite System for Common Carrier and Broadcasting Communication (AFROSAT) and for a Latin American remote sensing system, the Asian Regional Remote Sensing Programme, co-operation of ASEAN regarding the use of Indonesia's PALAPA satellites, etc.) - however, little progress has been made towards operational systems except in the case of PALAPA. Clearly a great deal more needs to be done.

366. The formulation and elaboration of principles of international space law and the creation of appropriate co-ordinating and regulatory mechanisms to ensure the

smooth and orderly growth of space technology and applications are functions that have been performed basically under the aegis of the United Nations and its related agencies. The specialized agencies - ITU, WMO and IMO in particular - have played a vital role in co-ordination and regulation, while COPUOS has served as the focal point for United Nations activities in the field of space. COPUOS and its two sub-committees have been instrumental in the elaboration of space laws and treaties. The United Nations system has contributed much to fostering co-operation in space; its role is dealt with more extensively in section E below.

367. In the context of international co-operation in space, it may be worth pondering over some of the lessons that have been drawn by some countries with active co-operative programmes. These may be summarized as follows:

(a) Co-operation must be the result of agreed means to reach a common goal or of complementary goals; these must be based on real needs and priorities of the countries concerned;

(b) Due regard must be paid to cultural, social, technological and economic differences, and particularly to administrative and organizational differences, between co-operating countries;

(c) Co-operation must bear promise of benefits to all parties concerned;

(d) Commitment to the ideals and benefits of co-operation among all concerned is essential, as is at least some degree of personal rapport at the operational level;

(e) Greater benefits are derived from co-operation which involves sharing of experiences and learning together rather than donor-recipient "co-operation" situations;

(f) Co-operation usually intensifies and becomes more productive as countries working together over a period of time discover the benefits of working together, and develop efficient mechanisms for doing so.

368. While these insights obviously cannot be universally true in all situations, they may serve as useful guidelines to start with.

## D. Co-operation between developing countries

369. The developing countries - despite their widely varying levels of economic, scientific, technological and industrial development - recognize the similarity of their problems and the complementarity of their needs and resources. Their widely varied levels of scientific, technological and industrial development, can, in fact, provide the basis for mutually beneficial co-operation in space applications, technology and science. Developing countries with greater experience in a particular space application, or with greater scientific and technological capability in a given field, can help other developing nations which may only now be getting into these areas. It is therefore highly desirable that developing nations get together and co-operate with each other, so as to collectively make the most of what they have.

370. While satellites operate in a common "neutral" environment, the ground equipment - which often forms a larger part of the total investment - has to operate in varying climatic and cultural environments. Equipment developed in and for developed countries is not always suitable for the physical environment of developing countries, and is even less suitable for their cultural environment: the way it is handled, carried, operated, etc. is generally somewhat different. In this regard, equipment developed by a developing country is more likely to be relevant and suitable for the total environment of another developing country. Efforts should therefore be made - both by the countries concerned and by international agencies - to encourage and stimulate the flow of equipment made by developing countries to other developing countries.

371. The above argument is equally applicable to "environmentally-suitable" experts. Experience has shown that an expert from a similar socio-economic and physical environment is likely to adapt quicker and work better in a foreign country. His experience is often more relevant and his recommendations generally more practical. Developing countries might, therefore, find it to their mutual advantage to seek and provide expert assistance - when required - from and to each other. National and international funding and technical assistance agencies, when providing expertise assistance, might first seek the necessary experts from developing countries.

372. For historical and other reasons, users from developing countries are more familiar with the equipment and expertise available in the developed nations rather than in other developing countries. It is necessary to increase, in developing countries, knowledge about the work being done and expertise available in other developing countries. To facilitate this, it is extremely important that developing countries should promote exchange of information and visits of scientists, technologists and decision-makers amongst themselves.

373. In this context, the global network for exchange of scientific information, recommended by the Conference for Science and Technology for Development, in its Vienna Programme of Action on Science and Technology for Development, should play an important role and should be given urgent consideration.

374. One problem faced by many developing countries - and small countries in particular - is the high cost of maintaining large inventories of spares for their limited operational facilities (e.g., satellite communication earth stations). As a result, critical spares are sometimes not available, leading to a system breakdown. Rather than maintaining large inventories for just one or a few facilities, it would be far more economical to have a joint regional store for selected critical but expensive spares. This would reduce inventory costs and at the same time reduce system down-time also. While the initiative to organize such regional stores must come from the countries concerned, they should be provided all possible support and encouragement by international agencies.

375. Collectively, the developing countries have between them accumulated a vast amount of experience in a wide array of space applications. They also have a great deal of experience in non-space areas relevant to space applications - e.g., photo interpretation, broadcasting, etc. - and on a variety of equipment. However, there has so far been very little exchange of this experience between the developing countries - especially on specifics like performance and problems of a particular piece of equipment in a particular operating mode and environment. Clearly, such

information would be invaluable during planning, procurement and operation/maintenance. Besides encouraging multilateral, regional and bilateral co-operation between the developing countries, the United Nations and concerned specialized agencies should examine how best to organize the collection, collation, documentation and dissemination of such experience.

376. Concrete and mutually beneficial co-operation between developing nations need not be restricted merely to the exchange of information, experts and experiences, or to regional stores of spares; it can extend much further - even to jointly-owned and shared ground and space hardware. While there are already some positive examples (see para. 363), such co-operation needs to be carried further and extended to more countries. The establishment of regional space agencies by groups of developing countries - as proposed for Latin America, for instance - could provide an effective mechanism for co-operation and a significant impetus to the use of space technology. Such initiatives should therefore be encouraged. The United Nations system and its regional economic commissions could play a supporting role in these initiatives.

377. Developing countries should take concrete steps to conceive, initiate and implement specific co-operative programmes among themselves on a regional, bilateral or multilateral basis. Such programmes can be of considerable mutual benefit in almost all fields of space applications - including communications, broadcasting, remote sensing, meteorology and navigation. Such co-operation could range from regional receiving stations for remote sensing data to joint ownership of complete systems. Cost-sharing and the use of complementary resources of the countries involved will result in far better cost-benefit ratios, while simultaneously helping to develop the infrastructure in these countries. At the same time, as in the case of ARABSAT, EUTELSAT, INTELSAT and INTERSPUTNIK, it is possible to devise appropriate organizational mechanisms combining joint ownership of one part of the system (e.g., spacecraft) with national ownership of other parts (e.g., earth stations).

378. Since the technical and economic advantages of jointly-owned systems are already obvious in many situations, the developing countries should, through an act of political will, take steps to implement such co-operative programmes. Where necessary, the United Nations and its specialized agencies should be provided with the means to fund expert missions to define specific, need-based, co-operative programmes between groups of developing nations.

379. While short-term and immediate benefits from space technology can be expected to be reaped by outright purchase of systems and turn-key contracts, including operation of facilities, in the long run it is obviously desirable - even essential - for each country to have its own pool of knowledgeable experts. The size of this pool, the depth of knowledge and breadth of disciplines required, would obviously vary from country to country. Training and education are therefore essential ingredients in any long-range plan for beneficial applications of space technology. Developed countries do have the best equipped, and often best run, training/educational facilities. However, these facilities often do not have the specific purpose of providing training and education compatible with the needs of developing countries. Therefore, the experience gained in such institutions is often not relevant for developing country situations. There are now, in some developing countries, at least a few centres which can provide training or on-the-job experience that is of high quality and of far greater relevance to

developing country situations. This is because of the similarity of situations and problems in developing countries, making work-experience gained in a developing country more useful than similar experience gained in a developed country. Thus, it would be most useful if developing countries with active programmes of space applications would provide on-the-job experience or training opportunities to persons from other developing countries. Such co-operation should be actively encouraged by the United Nations and its specialized agencies by providing available assistance, *inter alia*, funding for fellowships.

380. For many years the concept of technical co-operation between developing countries has been discussed extensively and was given special attention in the United Nations Conference on Technical Co-operation among Developing Countries, held in Buenos Aires in 1978. The implementation of this concept is still in the early stages and the important field of space applications presents another opportunity to put this idea into practice. If developing nations do not want to be denied the fruits of space technology, if instead they would like to use it as another means of accelerating development, then it is imperative that they take steps to work co-operatively and to derive the maximum benefit by pooling their limited resources. The recommendations in this section are an attempt to provide concrete shape to this desire, and should be considered as only the first steps in a series of bigger initiatives, which must follow.

## E. The role of the United Nations system: a review

381. The United Nations, along with its specialized and associated agencies, has been playing an important role in stimulating international co-operation and in helping to promote the utilization of space technology by all countries. A large number of United Nations divisions, agencies, etc. have been involved in this and their efforts have ranged from creating awareness about space technology to themselves undertaking or setting up agencies for operational activities in space applications. Here, no attempt is made to describe the activities of all the agencies or even to identify all of them. The focus is on the over-all impact of their collective efforts and recommendations to increase this.

### 1. Committee on the Peaceful Uses of Outer Space

382. A key role with regard to United Nations activities in matters concerning outer space is played by COPUOS. An *ad hoc* committee on outer space established by the General Assembly in 1958 was replaced by COPUOS (established in 1959). In a resolution in 1961, the General Assembly decided that within the United Nations system COPUOS should provide a focal point for international co-operation in the peaceful exploration and use of outer space. The Committee, which has a membership of 53 countries, has the mandate to discuss the state-of-the-art and future developments in the peaceful uses of outer space, to review international co-operation in this area and to study practical and feasible means for giving effect to programmes which promote such co-operation. It was also requested to study the legal problems that might arise from the exploration and uses of outer space and to organize exchange and dissemination of information relating to space activities. In accordance with this, it also carries out the task of progressive development and codification of international space law.

383. In undertaking these functions, the Committee is assisted by the two permanent sub-committees (Legal, and Scientific and Technical), and can draw on the experience of the specialized agencies and other bodies invited to participate in its work. On specific or technical matters, the Committee has, from time to time, established working groups to assist it.

384. The Committee has carried out several scientific, technical, economic and social studies relating to space communications, direct broadcasting, remote sensing, navigation and the use of nuclear power sources in outer space. It has taken important steps to promote the systematic and orderly growth of space activities, particularly by drafting and concluding five international treaties covering a number of vital issues (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; the Convention on International Liability for Damage Caused by Space Objects; Convention on Registration of Objects Launched into Outer Space; and the Agreement Governing the Activities of States on the Moon and other Celestial Bodies). Discussions on a number of other issues are continuing. These are legal aspects of remote sensing, direct international television broadcasting via satellite, use of nuclear power sources in space, and definition and delimitation of space, including matters relating to GSO. It has also given the impetus to an international education and training programme by establishing and guiding the United Nations Programme on Space Applications.

## 2. Outer Space Affairs Division

385. The Committee, its working groups and its Scientific and Technical Sub-Committee are serviced by the Outer Space Affairs Division in the Department of Political and Security Council Affairs of the United Nations Secretariat. The Division has responsibility for implementing decisions of the Committee and its subsidiary bodies related to the promotion of international co-operation and peaceful uses of outer space. It provides expert advice - on request - to Member States, carries out studies requested by COPUOS, disseminates information on space events to Member States through a monthly bulletin and maintains the international registry for objects launched into space. It services the Sub-Committee on Outer Space Activities of the Administrative Committee on Co-ordination. It also oversees the Programme on Space Applications, which was initiated in 1969, following the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. This Programme and the Expert on Space Applications have played an important part in increasing the awareness of all countries about the benefits to be derived from the applications of space technology.

386. Through the Programme on Space Applications, the Outer Space Affairs Division organizes, sponsors and conducts a variety of seminars, panels and workshops in fields of practical applications of space technology, particularly in space communications, space meteorology and remote sensing as applied in various disciplines including cartography, agriculture, forestry, geology, oceanography and other related earth sciences. As interest is expressed, various seminars/panels/workshops relating to specific problems or regions are organized in co-operation with concerned Member States and/or specialized agencies as a complement to activities undertaken by them. Over 30 such international seminars/panels/

workshops (with some 1,100 participants from developing countries) have been held in various parts of the world, including developing countries which have undertaken programmes aimed at integrating space technology in their economic and social development. Other organs of the United Nations have made important contributions in these, as have non-governmental scientific organizations.

387. Under the Programme on Space Applications, the United Nations can, upon request by Member States or organizations within the United Nations system, provide within the limits of resources available, technical advisory services in the applications of space technology for development. The Programme has also co-ordinated several surveys on the needs of developing countries in the utilization of space technology for development, including visiting missions to countries in the Middle East and Africa. The Programme is also responsible for the administration of fellowships for advanced training in fields of space science and technology which are offered by interested Member States to individuals of developing countries.

### 3. Office of Legal Affairs

388. The Office of Legal Affairs in the United Nations Secretariat provides secretariat assistance and services the Legal Sub-Committee of COPUOS. On request by the Legal Sub-Committee, the Office of Legal Affairs prepares reports and studie on items under consideration by the Legal Sub-Committee.

### 4. Natural Resources and Energy Division

389. Within the Department of Technical Co-operation for Development, the Natural Resources and Energy Division is responsible for a broad programme of activities in the fields of cartography (surveying and mapping), energy, geology and mining, and water resources. The programme consists of two basic types of activities: operational or field projects for technical assistance, and non-operational projects including studies, seminars and conferences. Both aspects of the programme focus on meeting the needs of developing countries.

390. Of primary interest to the Natural Resources and Energy Division is the use of remote sensing as a tool for resources exploration, particularly as it can benefit the developing countries. In this connexion, the Remote Sensing Unit within the Division co-operates with those sectors of the United Nations and its agencies responsible for project execution, particularly in the field of natural resources development. This co-operation involves such activities as providing substantive assistance in the design and evaluation of space-related remote sensing projects, facilitating access to satellite remote sensing data, advising on the feasibility of particular remote sensing applications and providing support for remote sensing centres being established in various regions. In a non-operational context, the Division participates, together with other United Nations bodies, in sponsoring various seminars and training programmes and in providing fellowships to individuals from developing countries.

### 5. Regional commissions

391. The regional commissions of the United Nations have made efforts to promote the use of modern technology to accelerate economic development. As a part of this function, they have promoted the use of space technology, as appropriate, to tackle the problems of the regions concerned.

392. The Conference of Ministers of the Economic Commission for Africa (ECA) adopted in 1975 a resolution which entrusted the Secretariat of the Commission with the development of an African remote sensing programme. The primary objectives of the programme are to make available to African countries satellite data needed for the development of renewable and non-renewable resources. To achieve this goal, an expert study lead by ECA recommended the establishment of three ground-receiving stations at Ouagadougou (Upper Volta), Nairobi (Kenya) and Kinshasa (Zaire) which would provide at least 90 per cent coverage of Africa. Also recommended was the establishment of five regional Training and Users Assistance Centres at Ouagadougou, Nairobi, Kinshasa, Cairo (Egypt), and Ile-Ife (Nigeria).

393. ECA initiated the African Remote Sensing Programme and arranged financial and technical assistance for the establishment and development of the needed supporting facilities. The Natural Resources Division was then entrusted with the responsibility to co-ordinate relevant projects and to provide technical backstopping to national and regional projects having a remote sensing component. At the instance of the African Remote Sensing Council, ECA carried out in 1981 an assessment on the harmonization and improvement of training policies in the regional centres.

394. ECA contributed to the establishment and development of the Pan-African Telecommunications Network (PANAFTEL), which will include a satellite component also. In the framework of the communication decade and in accordance with the Lagos Plan of Action which became the blue print of all African countries, the secretariat of ECA will collaborate with specialized intergovernmental agencies for the study of a regional communications satellite, AFROSAT.

395. The regional commissions also have been actively involved in a number of activities aimed at enabling countries to derive benefits from space technology. ECA and the Economic Commission for Latin America (ECLA), the Economic and Social Commission for Asia and the Pacific (ESCAP) and the Economic Commission for Western Asia (ECWA) helped in organizing regional/interregional seminars on space applications. ESCAP has initiated the Asian Regional Remote Sensing Programme and is actively promoting this. ECLA is also involved in promoting regional co-operation in remote sensing in the Latin-American region.

### 6. Office of the United Nations Disaster Relief Co-ordinator

396. UNDRO was established in 1972 to mobilize, direct and co-ordinate relief activities of the United Nations system in response to requests from disaster-stricken countries. Through appropriate international technical agencies, it promotes the study and prediction of natural disasters so that, working with such agencies, it can advise Member States and member of specialized agencies on preparedness measures through which the disastrous consequences of natural phenomena can be mitigated.

397. UNDRO activities focus on the development and use of data-gathering techniques for forecasting and predicting natural phenomena likely to cause disasters. It is studying the use of satellites for obtaining imagery for post-disaster relief co-ordination purposes and co-operates in sponsoring training programmes in the use of remote sensing for disaster forecasting and in the dissemination of information on relevant technological developments. Further details about UNDRO are to be found in Conference background paper A/CONF.101/BP/IGO/5.

### 7. United Nations Environment Programme

398. UNEP, created in 1972, has responsibilities which include co-ordinating environmental programmes within the United Nations system, reviewing their implementation and assessing their effectiveness. It also advises, as appropriate, intergovernmental bodies of the United Nations system on the formulation and implementation of environmental programmes.

399. Of primary interest to UNEP is the use of satellite remote sensing for the systematic collection of environmental data. UNEP is responsible for co-ordinating GEMS, a major and long-term programme that includes environmental survey activities in Member States, the specialized agencies and UNEP. The purpose of GEMS is to ensure the systematic collection of quantitative data for determining the state of the environment and for monitoring changes in critical environmental variables as a necessary input for environmental programmes. As part of GEMS a variety of projects are being executed in co-operation with FAO in such fields as the control of desertification, rangeland development and management, and the assessment of earth resources including forests and soils.

400. It seems certain that remote sensing techniques will play an increasingly important part in the activities of UNEP related to agriculture and land-use practices, climate impact studies, global ozone monitoring, etc. (see also chap. II H, para. 299).

### 8. United Nations Development Programme

401. The United Nations Development Programme (UNDP) is actively involved in developmental activities almost all over the world and has funded many projects in the space field. The majority of UNDP-funded projects relating to space science and technology are in the three fields of natural resources surveys, technology transfer and planning. Activities of special interest to UNDP include those in communications, weather and pest forecasting, radio and television broadcasting for development, and a variety of resource surveys, including crops, forestry, minerals, and soil and water. In addition, a number of projects related to different facets of space technology are currently in progress by collaboration with different United Nations specialized agencies.

### 9. International Telecommunication Union

402. The countries members of ITU and the ITU organs progressively have played a major and important role in the systematic planning, management and regulation of space communication activities through allocation, co-ordination, notification and registration of radio frequencies and positions on the GSO for the various radio

communication services using space techniques. The international co-ordinating and registering mechanisms for space radio communication are essentially those used and carried out over many years for conventional terrestrial radio communication. Essentially, the right of protection to an existing/registered radio operation is the premise on which the regulatory mechanism rests. The countries members, having included the necessary provisions in the international treaty (International Telecommunication Convention and the Radio Regulations annexed thereto), entrusted IFRB from 1963 with the added responsibility for the registration of technical basic characteristics of each space network station co-ordinated and notified under the Radio Regulations including the geostationary satellite orbital information, and, in 1973, included among the purposes of the Union specified in the International Telecommunication Convention "to effect, in the same conditions and for the same purpose, an orderly recording of the positions assigned by countries to geostationary satellites". A new article on "Rational use of the radio frequency spectrum and of the geostationary satellite orbit" has been added. CCIR and CCITT carry out various studies which result in important recommendations.

403. ITU organizes frequent WARCs to review and, where necessary, revise the pertinent portions of the ITU Radio Regulations, inter alia, (1) to take into account technical progress in the various fields and new requirements in radio communication services submitted by all countries in the light of article 33 of the International Telecommunication Convention which provides for equitable access to, and efficient and economical use of the geostationary satellite orbit and the radio frequency spectrum by all countries, and (2) to provide the basis for countries in a position to do so to develop techniques designed to improve the utilization of the radio frequency spectrum and the geostationary satellite orbit with a view to increasing the total radio communication facilities available to the world community. As early as 1959, at a WARC in Geneva, frequency allocations were made for the space research service; and in 1963, another world conference at Geneva was held at which frequency bands were allocated for the various radio communication services which were to use space techniques; and obligatory procedures, between countries and through IFRB, for the co-ordination, notification and registration of the use of radio frequencies and the geostationary satellite orbit were developed and adopted. These allocations and procedures were progressively reviewed, developed and revised in world conferences at Geneva in 1971, 1977 and 1979. The 1971 Conference established and adopted frequency allocations, technical criteria, and procedures dealing with Space Telecommunication Services. These were somewhat modified by WARC '79, and include the most up-to-date international radio-regulations for co-ordinating satellite systems. The WARC'77 agreed on a specific orbit/frequency assignment plan for the Broadcast Satellite Service in 12 GHz band for the countries of Europe, Africa, Asia and Oceania. A plan for the countries of the Americas is to be formulated by the Regional Administrative Radio Conference to be held in 1983. In 1985, another WARC is scheduled with the objective "to guarantee in practice for all countries equitable access to the geostationary satellite orbit and the frequency bands allocated to space radio communication services" (WARC, 1979, resolution No. 3), as part of a programme of world and regional administrative radio conferences to be held up to 1988.

404. Obviously, the whole régime of frequency allocation and co-ordination is dependent on co-operation for mutual protection and benefit. As the demand on resources like GSO and the radio frequency spectrum grows, and as the complexity of services increases, there is greater need for sharing and therefore for co-operation. All countries should therefore continue to work together in order to maximize the benefit to each.

405. Member States of ITU - themselves and through IFRB, CCIR, CCITT and the Technical Co-operation Department of the General Secretariat - also provide technical assistance in telecommunications. Short-term technical assistance is funded by UNDP, UNESCO and voluntary contributions by Governments. Such assistance includes frequency management and technical seminars, special pre-conference seminars, experts, fellowships, training in developed countries and provision of equipment. ITU also assists in the setting up of training centres - for example, in India, Malaysia, Angola, Malawi, Honduras, Ecuador - at which training is given to nationals both from the host country and from other countries in the region. ITU also presents an annual report to COPUOS on telecommunication and peaceful uses of outer space which summarizes the activities and progress made in this area.

## 10. World Meteorological Organization

406. The advent of artificial satellites has had a considerable impact on the activities of WMO and has resulted in very great benefits to national meteorological services throughout the world. The effect on WMO has in fact been so important that practically all the constituent bodies of the organization are engaged directly or indirectly in outer space activities. In this, it works in close co-operation with FAO and other concerned agencies.

407. The role of satellites has considerably increased not only in obtaining various kinds of observational data, in particular quantitative data, but also in providing a capacity for collection and distribution of information in support of various WMO programmes. Indeed, it is now generally recognized that satellites are indispensable for the success of the World Climate Programme (jointly with UNEP), WWW, GARP, the Tropical Cyclone Programme, IGOSS - jointly with IOC - the Hydrology and Water Resources Programme, agro-meteorological programmes and other WMO programmes.

408. WMO has also undertaken extensive education and training programmes for experts from developing countries in order to train them in the use of meteorological satellite data.

## 11. Food and Agriculture Organization of the United Nations

409. FAO has been using satellite imagery as an aid to its activities since 1969. It carried out experimental studies, using satellite imagery, in some countries in 1972-1973 and, in recognition of the great utility of space techniques to its work, FAO set up a remote sensing unit in 1976. In 1980, this was upgraded to a remote sensing centre, on the basis of the recommendation by COPUOS to set up two such centres in the United Nations system (the second centre is in the Natural Resources and Energy Division of the Department of Technical Co-operation for Development - see paras. 389, 390). The FAO Remote Sensing Centre has the responsibility within the United Nations system for renewable resources, and undertakes the following functions: advisory services and technical assistance to Member States, training courses for developing countries, support to the FAO field programmes, co-ordination of remote sensing activities at FAO headquarters and in the field, and serving as the liaison point between FAO and other major organizations concerned with space applications.

410. The Remote Sensing Centre acts as the organization's focal point for space activities. It provides technical backstopping to a large number of field projects whose work involves the application of remote sensing and develops projects where such applications predominate. It is closely involved in the formulation and execution of regular programme activities with a remote sensing component, including a range of activities carried out in collaboration with other United Nations agencies. It has developed facilities at FAO headquarters, among which are a global index of satellite imagery, including the LANDSAT 16 mm browse file, a library of such imagery for developing countries and of remote sensing literature, and a laboratory for the interpretation and analysis of aerial photographs and satellite imagery.

411. FAO organizes, sponsors and conducts a range of educational activities and training seminars, workshops and panels in fields of practical application of space technology in developing countries and by using the facilities of its Remote Sensing Centre for renewable resources in Rome. Much of its work is devoted to assisting Member States in establishing their own national centres and national infrastructures and advising and assisting developing countries and other international organizations in relation to the applications of remote sensing and the development of programmes and facilities for this purpose. The Centre is assisting towards the international co-ordination of satellite and airborne data and the development of associated national data bases, and also represents FAO in a range of bodies within the United Nations system and in international scientific organizations concerned with remote sensing. A more detailed exposition of FAO activities in this field is to be found in Conference background paper A/CONF.101/BP/IGO/6.

### 12. United Nations Educational, Scientific and Cultural Organization

412. UNESCO is also involved in space technology applications, especially space communication. It has sent expert missions to various countries to study the feasibility of satellite communications and has acted as executing agency for UNDP-funded projects aimed at strengthening programme production capabilitiy for satellite broadcasting experiments. It has also been a forum for discussion of matters relating to satellite broadcasting, and in 1972 adopted a declaration of guiding principles on the use of satellite broadcasting. The International Programme for the Development of Communication (IPDC) of UNESCO, established in 1980, expects to reinforce the activities in this field. A symposium on regional and international mechanisms for the dissemination and exchange of information took place in Paris in Autumn 1981. As a result of the meeting, a mission was sent to INTELSAT in Washington to discuss the use of satellite facilities by developing nations. A tentative agreement was reached on an experimental project for the use by third world broadcasts and the press of this satellite capability. This project was among those receiving some funding from the IPDC meeting in Acapulco, from 18 to 25 January.

413. The interests of UNESCO in remote sensing of the earth are mainly connected with its programmes concerning monitoring of the natural environment and its resources. The applications of space remote sensing and conventional (airborne) remote sensing techniques are being promoted and conducted in operational projects within the framework of MAB, IGCP, IHP, the Interregional Project on research and training leading to the Integrated Management of Coastal Systems, as well as in

several projects undertaken by its IOC. UNESCO has been sponsoring a number of regular post-graduate training courses in this general field and has promoted a series of activities on remote sensing applications in the form of symposia, seminars, workshops and ad hoc training courses, in collaboration with national and international institutions.

### 13. International Maritime Organization

414. IMO has, especially since 1966, taken a considerable interest in the development of space technology for maritime purposes. The culmination of this has been the creation of INMARSAT (see para. 337). IMO is now developing requirements of a future global maritime distress and safety system which is expected to be implemented in later years. This will make use of low-power distress transmitters (on ships and also on ships' survival craft) operating through geostationary and polar orbiting satellites which will also be used for shore-to-ship long-range alerting. This system will be developed in close co-operation with ITU and INMARSAT. IMO is also developing an international plan for the provision of maritime search and rescue services which will include procedures for routing distress messages to appropriate rescue co-ordination centres. Further details on IMO activities are to be found in Conference background paper A/CONF.101/BP/IGO/3.

### 14. International Civil Aviation Organization

415. ICAO has as an important objective: the economic application of satellite services to international civil aviation. It has accordingly been engaged in the definition of appropriate operational requirements and the best means of satisfying those requirements. The aeronautical fixed service, which interconnects the ground infrastructure responsible for the safety of flight, already utilizes satellite communication links where available and feasible. The aeronautical mobile service, which provides communications between aircraft in flight and the ground communication network, could benefit for the first time from the provision by satellites of instant, static-free communication between pilots and controllers over all parts of the earth's surface. The aeronautical radio navigation service could benefit from the application of satellites to provide radio-determination of aircraft position during flight over any part of the earth's surface, utilizing a variety of navigation techniques. In each of the two latter applications, the desirability of providing service over the polar regions adds to the complexity of possible solutions and extends considerably the range of technical problems which must be considered by ICAO.

416. ICAO is also concerned with other aspects of space, including use of satellites for search and rescue services, the obtaining and exchanging of aeronautical meteorological data, the definition of outer space, transport to and from outer space, problems related to safety, including the hazard caused to civil aircraft in flight by space debris returning to earth, etc.

417. The ICAO Assembly has resolved that ICAO be responsible for stating the position of international civil aviation on all related outer space matters. The resolution also requested the Secretary-General of ICAO to "ensure that the international civil aviation position and requirements are made known to all organizations dealing with relevant space activities and to continue to arrange for

the organization to be represented at appropriate conferences and meetings connected with or affecting the particular interests of international civil aviation in this field". The recent session of the ICAO Assembly decided that the Council of ICAO should continue to monitor the work of COPUOS and should request the ICAO Legal Committee, if and when necessary, to study with due priority the implications for the Chicago Convention, Annexes and other international air law instruments, of important decisions taken within the framework of the United Nations and other international bodies. Further details on ICAO activities are to be found in Conference background paper A/CONF.101/BP/IGO/1.

### 15. World Bank

418. The World Bank has been involved mainly in the funding of telecommunications earth stations for domestic and international traffic and is involved in studying the feasibility of using satellites for education. The World Bank also has an active interest in remote sensing and makes extensive use of satellite imagery, especially for the identification, preparation and monitoring of agricultural, irrigation and transportation projects. It provides assistance to many countries in the field of remote sensing, particularly for applications in the area of renewable resources.

### 16. Other agencies

419. Other specialized agencies, divisions, etc. within the United Nations system also have an active interest in space technology and its applications. A summary of this, and more details about the work of the agencies etc. mentioned above, are to be found in the Conference background papers (see A/CONF.101/BP/11 and A/CONF.101/BP/IGO/1, 3, 5, 6, 7 and 8).

### 17. Co-operation and co-ordination

420. Acting upon recommendations of COPUOS, the General Assembly has called upon organizations concerned to consider undertaking space science and technology programmes jointly or in close consultation or co-operation with one another. Such recommendations have included, for instance, those calling for co-operation in the implementation of WWW in the 1960s as well as in the subsequent programmes for the strengthening of meteorological services and research and for the expansion of training and educational opportunities in these fields, and those calling for co-operation in technical and other assistance to help meet communications needs of Member States and for the effective development of domestic communication.

421. Co-ordination of the space activities of the United Nations system is carried out by an Ad Hoc Sub-Committee on Outer Space Activities established under ACC. This interagency sub-committee, whose meetings are attended by representatives of the organizations concerned in the United Nations system, meets annually to work out joint programmes and co-ordinate their related activities. The results of its work are reported annually to COPUOS and its Scientific and Technical Sub-Committee.

## F. The role of the United Nations: an assessment and recommendations

422. As is obvious, space science and technology have developed over the last quarter of a century at a most dramatic rate. In recent years there has been an equally dramatic growth in the field of space applications, many of which have now reached an operational stage. Space technology clearly has important socio-economic implications, some of which are already visible; at the same time, its effects on all mankind - not merely on those who use it - could be substantial. All these considerations, which led to the convening of this Conference, and the initiatives which will result from it, call for an assessment of the role of the United Nations and for appropriate recommendations regarding its contribution to the process of enabling all States to benefit from space technology.

423. Regarding the financial implications of the recommendations made by this Conference, it is understood that the proposed new or expanded activities, including personnel costs, of the United Nations are to be funded mainly through voluntary contributions of States, either in money, or in kind. However, the decision itself to convene UNISPACE 82 demonstrates clearly that space science and technology are an area of increasing importance at the international level and should thus be given adequate priority within the United Nations. The Conference recommends therefore that the General Assembly through its competent organs rearrange priorities within the United Nations next regular budget in such a way that the modest increase in personnel costs proposed below may be absorbed within the available resources.

424. From the foregoing paragraphs reviewing the role of various elements of the United Nations system and taking into account concerns and suggestions expressed by States in their national papers, in COPUOS and other fora, the Conference examined the following specific points with regard to the role of the United Nations:

(a) Strengthening and expanding the role of COPUOS in accordance with its mandate as the only standing committee of the General Assembly for international co-operation in the peaceful uses of outer space;

(b) Giving fresh impetus and reorientations where necessary to the United Nations Programme on Space Applications;

(c) Strengthening and expanding the role of the Outer Space Affairs Division and the relevant divisions of the regional commissions so as to better enable them to fulfil their tasks in the implementation of the recommendations of the Conference;

(d) Finding appropriate ways and means to ensure smooth and prompt implementation of the Conference recommendations;

(e) Ensuring full co-ordination within the United Nations system with regard to space activities.

425. The following paragraphs briefly examine these and related issues and make specific recommendations.

426. The Conference strongly recommends that the competent organs of the United Nations - in particular the General Assembly and also the Committee on

Disarmament - when dealing with measures aimed at a prevention of an arms race in outer space - in particular those mentioned in the relevant resolutions of the General Assembly - give appropriate attention and high priority to the grave concern expressed in paragraphs 13 and 14.

427. COPUOS, which is responsible to the General Assembly, will remain the only intergovernmental body exclusively concerned with all aspects of peaceful uses of outer space and all related activities in the United Nations system. It should include on its agenda regular items pertaining to the follow-up of the Conference recommendations. COPUOS continues to be assisted by its two sub-committees, the Legal and the Scientific and Technical Sub-Committees. The Conference recommends that COPUOS should continue consideration of the best and most suitable working methods for the Committee and its two sub-committees.

428. Earlier sections of this report have recommended the conduct of a number of studies. While some of these studies fall into the prerogatives of Member States and regional organizations and require their direct initiative, many of the proposed studies will have to be conducted within the United Nations in association, where appropriate, with concerned specialized agencies and intergovernmental or non-governmental organizations. The studies proposed vary in scope and importance as well as in qualitative aspects. It is therefore recommended that the primary responsibility for arranging and/or conducting those studies remain with COPUOS, in accordance with the order of priorities established by COPUOS. The Committee will also have to decide on the most appropriate methods of conducting these studies, be it through the establishment of working groups of governmental experts within the framework of the Committee and its sub-committees, through ad hoc task forces or through hired consultants.

429. As noted earlier, the United Nations Programme on Space Applications plays an important role in promoting awareness about space technology and its benefits. It has performed this task to the satisfaction of Member States despite the very limited resources at its disposal. However, as needs grow and more and more countries become interested in the applications and use of space technology, it may not be able to meet satisfactorily the demands made on it. Developing countries have pointed out the need for not only more seminars, training courses, etc. but also for longer periods of exposure, greater depths of training and adequate financing for these activities. COPUOS has discussed for several years the need to expand the Programme on Space Applications and, at its request, the Expert on Space Applications has prepared a plan for such an expansion (see A/CONF.101/BP/11/Add.2).

430. At the same time, the Programme on Space Applications should move forward and play a more concrete role in helping requesting countries to select, execute and benefit from appropriate applications. Therefore, the Programme should be directed towards the following objectives:

(a) Promotion of greater exchange of actual experiences with specific applications;

(b) Promotion of greater co-operation in space science and technology between developed and developing countries as well as among developing countries;

(c) Development of a fellowship programme for in-depth training of space technologists and applications specialists, with the help of Member States and relevant international organizations; establishment and regular up-dating of lists containing available fellowships in all States and relevant international organizations;

(d) Organization of regular seminars on advanced space applications and new system developments for managers and leaders of space application and technology development activities as well as seminars for users in specific applications for durations as appropriate;

(e) Stimulation of the growth of indigenous nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries with the co-operation of other United Nations agencies and/or Member States or members of the specialized agencies;

(f) Dissemination - through panel meetings, seminars, etc. - of information on new and advanced technology and applications, with emphasis on their relevance and implications for developing countries;

(g) Provision or arrangement for provision of technical advisory services on space applications projects, upon request by Member States or any of the specialized agencies.

The Programme should continue to make full use of the expertise available in other organs of the United Nations system, and should be implemented in close co-operation and co-ordination with the concerned specialized agencies/departments of the United Nations system.

431. Apart from the Programme on Space Applications, being executed through the Outer Space Affairs Division, a number of other units of the United Nations system are involved in operational activities, training, etc. The Conference recommends that these activities be continued and strengthened as appropriate, but places special emphasis on the imperative need to avoid duplication of programmes and to achieve full co-ordination in this field (specific recommendations have been covered in chapter II).

432. As mentioned in chapter II, the need and the desirability of setting up an international space information service has been emphasized by many countries. The Conference therefore recommends that this international space information service should be established, initially consisting of a directory of sources of information and data services, so that Member States or any of the specialized agencies, upon request, could be directed through the service to accessible data banks and information sources. It is desirable that the basic information mentioned above is made available to all countries - particularly developing countries - requesting for it, at a reasonable cost. At a later stage, COPUOS could evaluate its performance and examine the need and possibilities of expanding the service, bearing in mind the financial implications of such a step.

433. The expanded role of the Outer Space Affairs Division and the relevant divisions of the regional commissions, the new orientation of the Programme on Space Applications and the setting up of an international space information service will require augmentation of technical personnel as appropriate, though a nucleus does exist. Closer and more active co-ordination of space activities is needed, especially in light of their growing importance and magnitude and in order to

ensure the best possible cost-efficiency. In addition to servicing COPUOS, the tasks to be carried out by the Outer Space Affairs Division and the relevant divisions of the regional commissions will thus considerably increase.

434. Those tasks will include:

(a) Present tasks of the Outer Space Affairs Division;

(b) Servicing COPUOS in the implementation of the approved Conference recommendations, with special regard to the proposed studies;

(c) Conduct of studies if so requested by COPUOS;

(d) Implementing the reoriented and expanded programme on space applications as recommended by the Conference;

(e) Organizing and operating the international space information service.

In order to meet these enlarged responsibilities, one possibility could be to consider an integration of the activities mentioned above into a Centre for Outer Space which would consist of the Outer Space Affairs Division of the Department of Political and Security Council Affairs. Alternatively, the proposed integration and expansion could take place within the existing Outer Space Affairs Division strengthened with additional personnel and resources. The Conference requests the General Assembly at its thirty-seventh session to consider both alternatives. In either case the financial considerations set out in paragraph 423 should be borne in mind.

435. Since this is basically an intensification of present functions of the Division, the activities of specialized agencies and other United Nations organs will not be infringed upon or duplicated. Indeed, the Conference stresses the need to avoid duplication of efforts and to observe the best possible cost-efficiency in the execution of programmes. This goal could be achieved by establishing or expanding close linkages between all United Nations bodies engaging in space or space-related activities, such as, for instance, the United Nations Centre for Science and Technology and UNDP. Also, the Ad Hoc Sub-Committee on Outer Space Activities of ACC should continue to meet annually. It should discuss ways of ensuring closer co-ordination between the various agencies concerned and should also examine the feasibility of using each other's expertise more fully through joint co-operative programmes. All space-related programmes of each of the agencies should be discussed and co-ordinated at this forum before finalization. The procedures of co-ordination should be such as to minimize delays in implementation.

436. The Outer Space Affairs Division with enlarged responsibilities or the Centre for Outer Space should work in close co-operation with the various technical agencies in the United Nations system - ITU, WMO, FAO (Remote Sensing Centre), UNEP, UNESCO and the Department of Technical Co-operation for Development (Natural Resources and Energy Division), in particular - as well as with funding agencies like the World Bank and UNDP, so that proper co-ordination of projects is ensured within the United Nations system.

437. The Conference recognizes that the effective participation of the regional commissions in the execution of activities resulting from the recommendations of

the Conference necessitates the reinforcement of the role of the regional commissions concerned and therefore recommends the provision of adequate resources.

438. The basic considerations of the Conference with regard to the aspect of financing its recommendations are set out in paragraph 423 above. In addition, however, the Conference recommends that its approved proposals be forwarded to the funding agencies and bodies with established operational activities, so that they may be taken into account in the planning and setting up of programmes.

## PART TWO

## PROCEEDINGS OF THE CONFERENCE

## CHAPTER I

## ORIGINS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

439. The General Assembly, at its thirty-third session, decided in resolution 33/16 of 10 November 1978 that a second United Nations Conference on the Exploration and Peaceful Uses of Outer Space should be convened. The General Assembly designated the Committee on the Peaceful Uses of Outer Space as the Preparatory Committee for the Conference and the Scientific and Technical Sub-Committee as Advisory Committee to the Preparatory Committee.

440. In resolution 34/67 of 5 December 1979, the General Assembly recalled that the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space was held in Vienna in 1968 and that the intervening period had seen rapid progress and growth in space exploration and in the development of space technology and its applications. The General Assembly considered that there was a need to assess these developments, to exchange information and experience on their present and potential impact and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology.

441. In the same resolution, the General Assembly recognized the importance of wider participation of Member States in the activities of the United Nations in the field of outer space, and noted the need to increase the benefits of space technology and its applications, as well as the need to contribute to the orderly growth of space activities favourable to the socio-economic advancement of mankind, in particular of the peoples of the developing countries. Taking into account new developments in space science and technology which are being projected and envisaged in the coming decade, as well as the applications emerging therefrom and their potential benefits and possible implications for national development and international co-operation, the General Assembly noted tht need to increase further the awareness of the general public with regard to space technology and its applications and expressed the desire to stimulate an enhanced co-ordinating role for the United Nations, which was eminently suited to bringing about increased international co-operation and assistance to the developing countries in the field of exploration and peaceful uses of outer space.

442. The question of convening such a conference had been before COPUOS, and its Scientific and Technical Sub-Committee since 1974. At the request of the Committee, the Secretary-General in 1974, sent a questionnaire to all Member States soliciting their views on the question of convening a conference.

443. In 1976, the Scientific and Technical Sub-Committee, at the suggestion of the Committee, established an informal working group to consider various proposals regarding a conference. Upon the recommendation by the Sub-Committee, the Committee requested the Secretariat to prepare a study in depth on the question of convening a United Nations conference on space matters.

444. The Committee, at its 1977 (twentieth) session, called on the working group of the Scientific and Technical Sub-Committee to consider the question and, to facilitate the work of the task force, requested the Secretariat to invite Member States to submit their views on the subject, focusing on the specific objectives, organizational aspects and financial implications of the proposed conference.

445. In 1978, the Committee noted that the working group of the Scientific and Technical Sub-Committee had considered all relevant facts and information relating to the proposed conference, including views expressed by Members of the United Nations. The Committee endorsed the views and recommendation of the Scientific and Technical Sub-Committee and recommended to the General Assembly that a second United Nations Conference cn the Exploration and Peaceful Uses of Outer Space be convened. As noted above (para. 439), this recommendation was adopted by the General Assembly at its thirty-third session.

446. As recommended by COPUOS at its 1978 session and endorsed by the General Assembly in resolution 33/16, the report of the 1978 (fifteenth) session of the Scientific and Technical Sub-Committee was circulated to all Member States, which were invited to comment in particular on the views and recommendations of the Sub-Committee on the need for a conference, the objectives of the conference and the organization of the agenda.

447. COPUOS held its first session as the Preparatory Committee for the Conference under the chairmanship of Ambassador Peter Jankowitsch (Austria) in June 1979, having before it the report of the Scientific and Technical Sub-Committee (A/AC.195/238) which had met under the chairmaship of Prof. J. M. Carver (Australia) in February 1979. The Preparatory Committee, in its report, 2/, made detailed recommendations to the General Assembly concerning the title, agenda, final report, preparation and organization of the Conference, and proposed a ceiling for its cost. It was agreed that the Conference should be held in the second half of 1982. Those recommendations were endorsed by the General Assembly in resolution 34/67 of 14 December 1979.

448. In 1980, the Advisory Committee held its first session from 28 January to 13 February, and the Preparatory Committee held its second session from 23 June to 3 July. The Preparatory Committee recommended that the Conference be scheduled for a duration of two weeks and approved the arrangements made by the Outer Space Affairs Division for the preparation of background papers for the Conference as requested by the Advisory Committee. The Preparatory Committee also made detailed recommendations on Conference participants and public information activities. The Committee noted with appreciation the invitations received from the Governments of the USSR and Austria to host the Conference and recommended to the General Assembly that it be held in Vienna from 9 to 21 August 1982. The General Assembly endorsed those recommendations in resolution 35/15 of 3 November 1980.

449. As requested by the General Assembly in resolution 35/15, the Secretary-General of the United Nations invited:

(a) All States Members of the United Nations or members of the specialized agencies to participate in the Conference;

(b) Namibia, represented by the United Nations Council for Namibia, to participate in the Conference;

(c) Representatives of organizations that have received a standing invitation from the General Assembly to participate in its sessions and the work of all international conferences convened under its auspices in the capacity of observers to participate in the Conference in that capacity, in accordance with General Assembly resolutions 3237 (XXIX) of 22 November 1974 and 31/152 of 20 December 1976;

(d) Representatives of the national liberation movements recognized in its region by the organization of African Unity to participate as observers, in accordance with General Assembly resolution 3280 (XXIX) of 10 December 1974;

(e) The specialized agencies and the International Atomic Energy Agency, as well as interested organs of the United Nations, to be represented at the Conference;

(f) Interested intergovernmental organizations to be represented by observers at the Conference;

(g) Directly concerned non-governmental organizations in consultative status with the Economic and Social Council to be represented by observers at the Conference.

The General Assembly also invited Member States to submit national papers for the Conference.

450. In October 1980, the Secretary-General of the United Nations appointed Prof. Yash Pal (India) as Secretary-General of the Conference. Prof. Yash Pal took office in March 1981. The other senior members of the Conference secretariat, including the Executive Secretary, three Deputy Secretaries-General and three Senior Advisers, were appointed and took office in January 1982.

451. In 1981, the Advisory Committee held its second session from 2 to 13 February and the Preparatory Committee held its third session from 22 June to 2 July. The Preparatory Committee, in its report, 3/ noted that the background papers had been issued and circulated, that national papers were being submitted and that regional seminars of the United Nations Space Applications Programme were oriented to focus on the preparations for the Conference. Such seminars were held in 1981 in Addis Ababa, Buenos Aires, Toulouse and Djakarta and in 1982 in Quito and Addis Ababa. The Preparatory Committee approved an outline of the draft report of the Conference and approved the draft provisional rules of procedure (A/CONF.101/1). The Preparatory Committee also agreed on the officers that would be required for the Conference and on the distribution of these posts among the regional groups.

452. The Secretary-General of the Conference prepared a draft report of the Conference (A/CONF.101/PL/L.17 and Add.1-4) based on the outline approved by the Preparatory Committee and taking into account the information in the background papers and the views expressed in the national papers and regional seminars. That draft report was submitted to and discussed by the Advisory Committee in January 1982.

453. In 1982, the Advisory Committee held its third and final session from 11 to 22 January and the Preparatory Committee held its fourth and final session from 22 March to 6 April. The Preparatory Committee considered and revised the draft report of the Conference, which had been prepared by the Secretary-General of the

Conference and revised to take into account the comments and observations made in the Advisory Committee, together with those received from specialized agencies (A/CONF.101/PC/L.20). As requested by the Preparatory Committee, the Secretary-General of the Conference circulated the revised draft report of the Conference (A/CONF.101/3) to all States 90 days before the opening of the Conference.

454. A variety of pre-Conference publicity activities, as approved by the Preparatory Committee, were conducted in 1981 and 1982. Those included five issues of a bimonthly newsletter, world-wide poster and essay contests, postage stamps issued by the United Nations and several countries, a series of monthly exhibits at United Nations Headquarters and a variety of articles and interviews in newspapers and magazines and on radio and television. In resolution 36/36 of 18 November 1981, the General Assembly invited Member States to promote public awareness of the Conference.

## CHAPTER II

## ATTENDANCE AND ORGANIZATION OF WORK

### A. Date and place of the Conference

455. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space was held in Vienna from 9 to 21 August 1982, in conformity with General Assembly resolution 35/15. During that period, the Conference held 13 plenary meetings.

### B. Pre-Conference consultations

456. Pre-Conference consultations open to all States invited to participate in the Conference were held in Vienna on 8 August 1982 to consider a number of procedural and organizational matters. The pre-Conference consultations were conducted under the chairmanship of Ambassador Peter Jankowitsch (Austria), Chairman of the Preparatory Committee for the Conference, who presented the report on the consultations (A/CONF.101/L.1) to the Conference at its opening meeting. The Conference accepted that report as a basis for the organization of its work.

### C. Attendance

457. The following 94 States were represented at the Conference:

Albania
Algeria
Angola
Argentina
Australia
Austria
Bangladesh
Belgium
Benin
Bolivia
Brazil
Bulgaria
Byelorussian Soviet Socialit
  Repubic
Canada
Chile
China
Colombia
Costa Rica
Cuba
Cyprus
Czechoslovakia
Democratic Yemen
Denmark
Ecuador
Egypt
Finland
France
Gabon
German Democratic Republic
Germany, Federal Republic of
Greece
Guatemala
Holy See
Hungary
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Japan
Kenya
Kuwait
Lebanon
Lesotho
Libyan Arab Jamahiriya
Luxembourg
Malaysia
Mali
Sri Lanka

Mexico
Morocco
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Panama
Peru
Philippines
Poland
Portugal
Qatar
Republic of Korea
Romania
Rwanda
San Marino
Saudi Arabia
Senegal
Somalia
Spain
Sudan
Sweden
Switzerland
Syrian Arab Republic
Thailand
Tunisia
Turkey
Uganda
Ukrainian Soviet Socialist Republic
Union of Soviet Socialist Republics
United Kingdom of Great Britain and Northern Ireland
United Republic of Cameroon
United Republic of Tanzania
United States of America
Upper Volta
Uruguay
Venezuela
Viet Nam
Yugoslavia
Zaire
Zimbabwe

458. The United Nations Council for Namibia was represented at the Conference.

459. The following national liberation movements were represented by observers: African National Congress (South Africa) and Pan-Africanist Congress of Azania.

460. Members of the secretariat of the following United Nations offices were present throughout or during part of the Conference:

Centre for Disarmament;

Centre for Science and Technology for Development;

Department of Political and Security Council Affairs.

461. The Secretariat of the Economic Commission for Africa was represented at the Conference.

462. The following United Nations Secretariat units and bodies were also represented:

United Nations Centre for Human Settlements (Habitat)

United Nations Environment Programme

United Nations Industrial Development Organization

United Nations Disaster Relief Organization

United Nations Development Programme

463. Representatives of the following specialized agencies and related organizations participated in the work of the Conference:

Food and Agriculture Organization of the United Nations
United Nations Educational, Scientific and Cultural Organization
International Civil Aviation Organization
World Health Organization
World Bank
International Telecommunications Union
World Meteorological Organization
International Atomic Energy Agency

464. The following intergovernmental organizations were represented by observers:

African Remote Sensing Council
Agency for Cultural and Technical Co-operation
Arab Communications Satellite Organization
Council for Mutual Economic Assistance
Council of Europe
European Communities
European Space Agency
Intergovernmental Oceanographic Commission
International European Telecommunications Satellite Organization
International Maritime Satellite Organization
International System and Organization of Space Communications
International Telecommunications Satellite Organization
League of Arab States
Organization of African Unity
Pan African Telecommunications Union

465. A large number of concerned non-governmental organizations in consultative status with the Economic and Social Council were represented by observers.

### D. Opening of the Conference and election of its President

465. The Conference was opened by the Secretary-General of the United Nations, Mr. Javier Pérez de Cuéllar. He noted that space technology, which has advanced demonstrably in the past 25 years, offered man a new tool, a tool that could be used for the common good or for the benefit of a privileged few. Space technology, he pointed out, was a tool of immense versatility and great power. It could be used to help improve life on earth or to devastate the planet, to spread knowledge, education and enlightenment or to destroy cultures and values.

467. He went on to note that space provided an ideal and necessary arena for international co-operation in aeas ranging from communication to weather data. International co-operation in the utilization of outer space would not only benefit

humanity at large, but would further decrease spheres of international confrontation, leading closer to the final goal - namely, the use of outer space for exclusively peaceful purposes.

468. This optimistic picture, he observed, was marred by the fact that not all countries had been able to participate equally in space technology, nor had all partaken equally of its benefits. However, in trying to harness space technology for development, it was not necessary - nor even desirable - that all countries should follow the same, well-trodden path. The needs, resources, culture and national genius of peoples varied from country to country and the applications of the new space technology should, therefore, be tailored to fit in with the socio-economic and cultural fabric and goals of each nation. If this was not done, the Secretary-General warned, there was a danger of space technology acting as a disruptive force, as a means of accentuating disparities within a nation, even as one attempted to reduce inter-country disparities.

469. He went on to observe that space science and technology demonstrated as never before the total interdependence of nations and he stressed the importance of acting quickly to avoid the escalating militarization of outer space, a trend which ran against the principle of international co-operation for the advantage of all, and the peaceful use of outer space to build rather than to destroy. An arms race in space, he remarked, would increase the areas and the potential for confrontation, adding a new dimension to the human destruction that would stem from it; it would also divert urgently needed resources from programmes of economic and social development. Hence, the increased militarization of outer space must be vigorously opposed. There was time - but very little. Almost daily one read of proposals and plans to increase the military component of space programmes. He underlined that it was therefore essential that the forces of reason and peace join together to counter what could be a frightening escalation of the arms race.

470. In conclusion, the Secretary-General stated that, as more and more countries become increasingly dependent on space technology for essential services, the need for co-operative planning and co-ordination would grow. This would involve new relationships between national, regional and international organizations. While much of this co-operation and co-ordination would be bilateral, global structures would also be required. Therefore, he believed that the United Nations system would continue to have an important role to play in this area, as well as in the continued development of space activities.

471. Dr. Rudolf Kirchschlaeger, Federal President of the Republic of Austria, the host country for the Conference, in his inaugural address, welcomed the participants and stated that based on its geographical position and its history, his country had been striving to offer a meeting place for conferences, negotiations and talks which it regarded as the most reliable means to find solutions to global problems.

472. The Austrian President expressed the hope that the Conference would intensify international co-operation in space research and ensure that outer space was used for peaceful purposes. In noting the extraordinary and impressive development of space science and technology which had occurred over the last decade and a half, he asked what that scientific progress would be worth if it were to be accompanied by new and additional threats to world peace. He appealed to the countries and organizations represented at the Conference to use all their scientific knowledge and technologies for peaceful purposes only.

473. In conclusion, Dr. Kirchschlaeger cited the necessity for internatioal co-operation in the uses of outer space, because global problems call for global solutions. Furthermore, he saw co-operation in space as a symbol and example for coping with other problems existing in the world today. He expressed the hope that the Conference would advance the goal of a peaceful and harmonious future for one mankind, not divided into races and classes, or into rich and poor, but one that had learned to live in lasting peace.

474. The Conference elected by acclamation Dr. Willibald Pahr, Federal Minister for Foreign Affairs, head of the delegation of Austria, as President of the Conference.

475. The President of the Conference addressed the assembled representatives and participants. In acclaiming the development of international co-operation in outer space activities over the past 25 years, he noted the increasing concern and involvement of the non-space Powers, including developing countries, in space-related fields. Space applications, he pointed out, were no longer the domain of solely a few rich and highly industrialized nations; rather, the potential of space technologies for accelerating the process of development had been recognized by developing countries as well.

476. The President praised the effectiveness of the 1967 Treaty on the Peaceful Uses of Outer Space, as well as of other international treaties and conventions which had resulted form the work of COPUOS, in preventing a situation of confrontation and conflict from rising along with the development of space technologies. In the recent past, however, many of the ideas and principles enshrined in those instruments had been exposed to an increasing challenge. There had been a deterioration in the very spirit of international co-operation which, the President warned, was being eroded by increasingly nationalistic considerations. As he noted, for the first time in many years the spectre of military confrontation in space was rising, fuelled by the pursuit of technological research and applications which could lead to a costly and destabilizing arms race in space. As long as those programmes were not fully operational, however, he saw a chance for the world - and, in particular, the two major space Powers - to stop those dangerous developments. He urged, therefore, that appropriate consideration be given by the Conference to providing the international community with the effective machinery to guarantee the exclusively peaceful uses of outer space.

477. The second plenary meeting of the Conference opened with live televised messages via satellite from the heads of State of Sri Lanka and Brazil.

478. The President of Sri Lanka, H.E. J. R. Jayewardene, greeted the delegates and wished them all success in their endeavours. In his view, the Conference must have as its purpose not just the sharing of knowledge, but the use of knowledge in the service of all mankind. While noting the fact that earthly preoccupations had, in the past, prevented developing countries from participating in the exploration and uses of outer space, he stated that those countries were no longer satisfied with remaining mere spectators of the great adventure of space science and technology. He went on to warn of the potential use of satellite technology for destructive ends aS the greatest challenge facing humanity today.

479. In his message to the Conferenc, the President of Brazil, H.E. Joao Baptista de Oliveira Figueiredo, called the task at hand the leading edge of human activity. He urged the participants not to detach the technical discussions

of space research and development from the economic, social and political facts of the planet. Nothing would contain a greater element of risk than to pretend that science existed in the abstract, with no influence on human relations or without being influenced by them. He went on to contrast the many benefits attainable by remote sensing by means of satellites with the potentially harmful effects in developing countries by impinging on sovereignty of States over their natural resources. Similar advantages and disadvantages, he noted, derived from direct television broadcasting by satellites. Finally, he warned of the growing possibility of the use of outer space for war-like purposes.

480. Three messages from other heads of States were read to the Conference participants by the heads of their respecteive delegations.

481. The Premier of the State Council of the People's Republic of China, H.E. Zhao Ziyang, extended warm congratulations to the Conference on behalf of the Chinese Government and people. He expressed the hope that the Conference would make a positive contribution to the promotion of outer space science and technology in the service of peaceful purposes, to the enhancement of co-operation based on equality between all States Governments and peoples and to the furtherance of the economic and social progress of all countries, in particular developing ones.

482. The Prime Minister of India, H.E. Mrs. Indira Gandhi, noted that the past 25 years since man first successfully demonstrated his ability to launch objects into space had witnessed many notable achievements. However, she asked whether those advances had also contributed to reducing the glaring disparities which divided peoples. The promise of gains from advanced technologies eluded the majority of humankind, whose aspirations for a better life remained unfulfilled. She therefore urged scientists and world leaders to see the world in its wholeness and, through their collective wisdom, to take practical steps to ensure that global differences would not be extended into space.

483. In his message, Mr. Leonid I. Brezhnev, Chairman of the Presidium of the Supreme Soviet of the Union of Soviet Socialist Republics, noted that the Conference was convening on the twenty-fifth anniversary of the launching of Sputnik I, one of the greatest achievements in man's history. He noted the present wide use of space technology in different fields of earth-bound economic activities and the prospect that space laboratories based on large orbital complexes with changing crews would be permanently operational in orbit in the near future. He expressed satisfaction with the development of international co-operation in the exploration and use of outer space, in which the United Nations played a remarkable role, and stressed that the first international crews were placed in orbit thanks to INTERCOSMOS programmes. He emphasized his country's constant advocacy of outer space remaining an arena for peaceful co-operation and the urgent necessity to keep the space free from weapons of any kind.

484. Further messages from the heads of State of Pakistan, Bulgaria and the United States were received during the course of the general debate and were read at the outset of their statements by the heads of their respective delegations.

485. In the message read on his behalf, President Mohammed Zia ul Haq of Pakistan noted that activities in space had begun to exercise a significant and, to a large extent, beneficial influence on people's lives in many diverse ways. Unfortunately, he pointed out, there was another side to the coin, inasmuch as an estimated 75 per cent of the satellites launched since the first Sputnik had

military applications. He hoped, therefore, that UNISPACE 82 would do its best to ensure that the promising new frontier of space did not become an arena for military competition and confrontation, but rather that outer space would be used only for peaceful purposes and for the benefit of all humanity.

486. A message from Todor Shivkoff, Chairman of the State Council of Bulgaria, was read to the assembled delegates by the head of the Bulgarian delegation. In it he noted that the exploration and peaceful uses of outer space were among the great achievements of the scientific revolution of the twentieth century. The Chairman stated that outer space was the common heritage of mankind, as well as was peace. Therefore there must be no weapons of any kind stationed in space.

487. President Ronald Reagan of the United States of America, in his message, stated that the Conference provided leaders from around the globe with an unprecedented opportunity to chart a course for greater co-operation among nations in exploring mankind's last and endless frontier. He urged countries to work together to ensure that the benefits of space continue to contribute to a bright and peaceful future on Earth and to chart new pathways to the stars to serve as avenues of peaceful exploration and adventure for our generation and for generations to come. Since 1968, he pointed out, developing countries had made some use of space technology, but their social and economic hopes had not been fulfilled. Indeed, Prof. Pal noted, the gap between rich and poor nations had widened, owing in part to the pattern of use of technology, including space technology. While one could not expect an instant "technological fix", technology properly used could be an engine for development and well-tailored applications could help reduce economic and social disparities. The challenge was to devise methods and means to accomplish that aim on a large scale and in an ongoing manner.

488. Following messages from heads of State, the Secretary-General of the Conference, Prof. Yash Pal, made a statement in which he noted that when one spoke of space, the perspective must necessarily be global. One must consider and discuss how space could contribute to the well-being of humanity as a whole.

489. In recent years, Prof. Pal said, ever-greater numbers of countries had been making use of space technology in one form or another. However, despite the seemingly extensive use of such technology, the fact was that the benefits had been minimal in most cases - and certainly far less than their potential. Meanwhile, Prof. Pal pointed out, applications that could create a real impact - communication and education in remote rural areas, or integrated weather-forecasting and communication systems, for example - had not been extensively used. In those fields, countries had been provided with snippets and their appetites had been whetted. An increasing addiction was being developed with little effort to understand distinctive needs or to suit systems to requirements. Such an approach, an over-selling of space technology, could only bring it into disrepute. At the other extreme was the view that space technology was bad per se and that developing countries should limit themselves to so-called "intermediate technologies". According to Prof. Pal, both those viewpoints betrayed a lack of understanding of the relationship between needs and technology in general, and space technology in particular. While every country need not embark on a space programme, he underlined the belief that space technology could be an important tool for combating poverty, for spreading education and for strengthening indigenous cultures.

490. However, the growing use of space applications and the widespread sharing of its benefits would seem, Prof. Pal felt, to require some assurance that the availability of satellites, launch services or equipment would not depend upon the vagaries of political relations. He noted that while that might appear to be a tall order, such insulation from politics had indeed been achieved, to a large extent in such fields as international telecommunication and maritime communication. At the same time, however, Prof. Pal felt obliged to mention the realities of outer space today. The "weaponization" of outer space, he emphasized, was a dangerous and regrettable step, which must be combatted.

491. In this last quarter century, Prof. Pal concluded, man had acquired capabilities undreamt of even a few decades ago, including the capacity effectively to abolish distances and thereby create a completely new concept of "neighbourhoods". In this situation, he asked, should mankind not begin to conceive of new "minimal human rights" which would include the right to communicate and the right of access to meteorological information.

## E. Adoption of the rules of procedure

492. At its 1st plenary meeting, on 9 August 1982, the Conference adopted the provisional rules of procedure recommended by the Preparatory Committee (A/CONF.101/1).

## F. Adoption of the agenda

493. At the same meeting, the Conference adopted the following agenda recommended by the Preparatory Committee (A/CONF.101/2):

1. Opening of the Conference
2. Election of the President
3. Adoption of the rules of procedure
4. Adoption of the agenda
5. Establishment of the Main Committees and organization of work
6. Election of officers other than the President
7. Credentials of representatives to the Conference
    (a) Appointment of the members of the Credentials Committee
    (b) Report of the Credentials Committee
8. General debate
9. State of space science and technology
    (a) Review and projection of the current and future state of science and technology for space research and applications

(b) Evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far

10. Applications of space science and technology

(a) Evaluation of the current and potential applications of space technology, taking into account present and foreseeable national and international programmes in the areas of space research

(b) Examination of the possibilities and mechanisms for enabling all States to benefit from space technology, bearing in mind their various levels of development, varying capacities to absorb new technologies and particular needs and priorities

(c) Examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard

(d) Examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measures to augment their capabilities to develop space technology and facilitate access to such technology and to participate and co-operate in space activities so as to derive maximum benefit from space technology and its applications

(e) Examination of developments and system configurations appropriate to the use of space technology for education

(f) Discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation

(g) Consideration of the implications of projected developments in the areas of space technology such as earth-orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end

(h) Discussion of the nature of, and ways of protecting, the near-earth environment including the upper atmosphere and magnetosphere

11. International co-operation and the role of the United Nations

(a) Consideration of reports on the nature and extent of the bilateral and multilateral co-operation in outer space activities

(b) Consideration of reports on the activities of the United Nations, including its specialized agencies, and of other international organizations dealing with the exploration and peaceful uses of outer space

(c) Evaluation of the role of the United Nations, its specialized agencies, other international organizations and programmes of bilateral and multilateral co-operation in order to ensure broad international co-operation on an equal basis

(d) Evaluation of the role of the United Nations in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role

12. Adoption of the report of the Conference

## G. Establishment of the Main Committees and organization of work

494. Also at the 1st plenary meeting, the Conference decided to establish three Main Committees. It further decided:

(a) That items 1 to 8 and item 12 would be considered in plenary meetings;

(b) That item 9, as well as the introduction to the draft report, would be considered by the First Committee;

(c) That item 10 would be considered by the Second Committee;

(d) That item 11 would be considered by the Third Committee.

## H. Election of officers other than the President

495. Also at its 1st plenary meeting, the Conference elected the following 17 States as Vice-Presidents:

Australia
Bulgaria
Canada
China
Colombia
Ecuador
Egypt
Germany, Federal Republic of
Indonesia
Iraq
Nigeria
Pakistan
Peru
Romania
Senegal
Uganda
Upper Volta

496. The Conference elected Mr. Carlos Antonio Bettencourt Bueno (Brazil) Rapporteur-General by acclamation.

497. The Conference elected by acclamation Dr. Robert Knuth (German Democratic Republic) Chairman of the First Committee, Dr. Minoru Oda (Japan) Chairman of the Second Committee and Mr. David K. Andere (Kenya) Chairman of the Third Committee.

498. The Conference appointed as "Friends of the Rapporteur-General" Mr. Alain Chappe (France), Mr. Rogelio Driollet (Argentina), Mr. Ahmed Fawzi-Hilal (Libyan Arab Jamahiriya), Mr. Juwana (Indonesia), Mr. Reinhard Loosch (Federal Republic of Germany), Mr. Mostafa Masmoudi (Tunisia), Mr. Boris Mayorsky (USSR), Miss Alba Petracio (Venezuela), Mr. Y. S. Rajan (India) and Mr. Ales Triska (Czechoslovakia).

## I. Appointment of the members of the Credentials Committee

499. At the 5th and 6th plenary meetings, the Conference appointed the following States as members of the Credentials Committee: Algeria, Angola, Chile, China, Netherlands, Panama, Philippines, USSR and the United States.

## J. Implications of Conference decisions for the programme budget of the United Nations

500. At the 13th (closing) plenary meeting of the Conference, on 21 August 1982, the Executive Secretary of the Conference made a statement to the effect that any provisions of the decisions or recommendations of the Conference that had implications for the programme budget of the United Nations would be brought to the attention of the General Assembly by the Secretariat at the time when the General Assembly considers the report of the Conference.

## CHAPTER III

## SUMMARY OF THE GENERAL DEBATE

501. The general debate, agenda item 8 of the Conference, took place in the course of nine plenary meetings, held from 9 to 13 August 1982. During the general debate, the Conference heard statements by the representatives of 67 States, of 3 specialized agencies, and 5 other United Nations Secretariat units and bodies, and of 5 other intergovernmental organizations as well as by observers for non-governmental organizations. Following is a brief account of the points which were stressed by the speakers in the debate.

502. Many delegations noted the great strides that had been made in the exploration and peaceful uses of outer space since the first artificial earth satellite was launched 25 years ago. Human beings have been in space, in some cases for extended periods, and have walked on the Moon. It was noted that unmanned spacecraft had landed on the Moon, Venus and Mars and had made detailed observations of Jupiter and Saturn from trajectories passing close to those planets. Astronomical observatories in orbit were observing celestial objects and phenomena that were not readily observable from the ground.

503. Many delegations referred to the great impact space activities were having in many countries, not only on economic activities, but also socially, culturally and even philosophically. It was suggested that space science and technology were creating a "new global awareness" due to the new capabilities and the new needs for communication and exchange between countries. The scientific study of space and the study of the earth from space had provided people with new perspectives. Space science provided new information on the evolution of the universe and the solar system and on the origin of life on earth. The study of other planets could make important contributions to the understanding of the stability of the earth's environment and the potential effect of human activities on that stability.

504. Many delegations pointed out that the Conference was meeting at a time when space activities were gaining an ever-increasing significance in everyday life in all regions of the world and advances in space technology were assuming ever greater relevance, not only for the industrial countries, but also for the economic and social progress of the developing world. Among the major themes that recurred in many statements were (a) the rapid, even accelerating, advances in space technology which have taken place during the past quarter century; (b) the increasing gap in space technology between the developed and developing nations; (c) the need for international co-operation to enable all countries, and in particular the developing countries, to enjoy the potential benefits of the new space technology; (d) the dangers posed by an extension of the arms race into outer space and the need to ensure that outer space is used for peaceful purposes only.

505. Numerous delegations referred to their countries' increased capabilities in utilizing space technology to solve earth-bound problems. Many countries, including developed and developing countries, emphasized the achievements in the field of telecommunications and the progress that had been made in such areas as remote sensing, meteorological forecasts, navigation and other services. References were also made to plans for satellite systems for direct television broadcasting, domestic and regional communications, and navigation. While most delegations emphasized earth-oriented applications, there was also discussion of

biological and materials research in the space environment, missions to Jupiter and Halley's comet and astronomical studies from space.

506. Many delegations noted that, due to the cost and complexity of space technology and to the global or regional coverage inherent in satellite orbits, international co-operation in space was highly advantageous. It was recognized that co-operation was not a one-sided proposition since potentially it could benefit all concerned. Some delegations pointed out that interational co-operation in outer space was not only expedient but imperative. The hope was expressed that the Conference would itensify international co-operation in space. A number of delegations noted that their countries saw the Conference in the context of the ongoing efforts to promote the new international economic order which space technology, if properly used, could support. The view was also expressed that UNISPACE 82 was related to other United Nations conferences as a continuing forum for the North-South dialogue and that one of its major goals was the lessening of the developing countries' technological dependence on the industrialized nations.

507. The discussion of ways to reduce the technology gap between developed and developing countries focused on the need for transfer of technology through education and training and financial aid of various sorts to defray the cost of expensive foreign technologies and equipment. The view was expressed that in order to reduce the above-mentioned gap, and in addition to stressing self-reliance and mutual co-operation among developing countries, the developed countries with more advanced space technology should assume special responsibilities. Some countries with space capabilities indicated their willingness to give favourable consideration to requests for technical assistance in the form of scholarships for education and training.

508. Some delegations also focused attention on the development of new technologies. It was stated that the needs of users should be put first in the development of new technology, as well as in its application, and that technological development should not be pursued purely for its own sake. The view was expressed that potential commercial demand could help motivate discoveries and applications since space technology was very expensive to develop. Some delegates felt, on the other hand, that a consumer-oriented approach was inappropriate to space technology, which required a more broad-based outlook. In considering the development of new space technology, several representatives noted the need for compatibility and complementarity among the space systems and technologies of different countries.

509. The discussion of international co-operation in the development of technology focused on the complementarity and compatibility among space systems developed by different States and on the unrestricted and equitable use of space technology. Several developing countries suggested that co-operation with the industrialized nations, including technical assistance and the financing of research and training programmes, would enable them to take advantage of the potential of space technology. The view was also expressed that it was important to distinguish between true co-operation and trading and selling of space technology. Countries involved in space technology were urged to make a commitment to co-operate both multilaterally and bilaterally with the developing countries. It was stressed - both by developing and developed countries - that the developing countries should increase co-operation among themselves in order to develop effective and efficient applications of space technology.

510. Attention was also drawn to the advantages of regional co-operation. It was noted that regional co-operation on well-defined projects could yield optimal benefits, since it flowed from common problems and interests. In view of such potential benefits, a proposal was made for the establishment of a Latin American regional space organization. Some developed countries made the point that space applications projects based on operational systems required large investments which, for smaller countries, could not be justified, on a purely national basis.

511. It was noted that remote sensing satellite data had proved very useful for environmental monitoring, geological prospecting, water resource development, agricultural and forest inventories, and air and water pollution surveys. Furthermore, data from meteorological satellites operating within the context of WWW were an integral part of weather forecasting services. The proposed SARSAT and COSPAS systems, both concerned with marine search and rescue, were mentioned as excellent examples of the humanitarian use of space technology.

512. Most delegations noted the usefulness and value of satellite remote sensing and meteorology. It was noted that satellite systems could assist in development surveys, agricultural early warning systems and disaster warning and relief, thereby improving the condition of humanity worldwide. Most delegations felt that such programmes could assist in narrowing the gap between developed and developing countries. Many delegations, however, also pointed to the dangers of the misuse of satellite data for military preparations or for interference with countries' national rights with respect to their territories and natural resources.

513. The need to ensure continuity and compatibility of satellites services was noted by many delegations. Delegations of developing countries, who could be expected to be users rather than suppliers of remote sensing satellites, stressed the importance of those assurances. The importance of appropriate spatial resolution, temporal coverage and data formats was noted. The need for a specific and over-all code regulating the use of remote sensing satellites was strongly expressed by some delegations, especially those of developing nations.

514. Some delegations expressed serious concern regarding the dissemination of data collected by remote sensing satellites. While several developed and developing countries felt that such information should be freely available to any interested State, most delegations felt that the consent of the sensed State should be required before data could be released to a third State organization or third party. Some developing nations felt that the consent of the sensed State must be obtained before sensing, even if the information was not to be disseminated beyond the concerned States; some felt that in no case should the information be available to any State other than the sensor and sensed States. Most representatives expressing an opinion on the point agreed that priority in access to data must be accorded the sensed State.

515. Many delegations observed that the technology and applications of satellite remote sensing and meteorology were developing rapidly and that there was a great need for trained personnel. Many developing countries felt that such personnel should be indigenous and that the technology and applications should be tailored to local needs and capabilities. Several delegations felt that the United Nations should establish a satellite data service to handle all remote sensing data and that regional centres could provide data to this service. Some delegations proposed that such a service should distribute data, while others felt that an information "clearinghouse" for satellite data would be more appropriate. Some

delegations suggested a world-wide system for earth observation, including resource surveys, environmental monitoring and even treaty compliance or other military activity monitoring.

516. In the discussion of telecommunications and the geostationary orbit, most countries felt that decisions should be made internationally in an organized manner so that the geostationary orbit and radio frequency spectrum would be accessible to all without restriction and used in an equitable and efficient manner. While some delegations expressed the view that specialized agencies of the United Nations, such as ITU, were the appropriate bodies to consider technical details relating to the efficient use of the geostationary orbit, several delegations felt that the Conference should provide some general guidelines. Some countries suggested that a specific legal régime under the United Nations or ITU should be established to regulate the use of the geostationary orbit and radio frequency spectrum, while other countries considered that ITU should co-ordinate use of those resources.

517. Some of the equatorial countries expressed the view that they had sovereignty over the sector of the geostationary orbit above their countries. A number of other developing countries agreed that the interests of the equatorial countries should be taken into account. Those countries warned of the possible adverse effects on their interests which might result from unrestricted use of the geostationary orbit. Other delegations did not share those views.

518. While most countries felt that technological progress by the developing countries should be encouraged, some developing countries urged the technologically advanced countries to assume responsibility for adoption of newer and more efficient communication technologies, thereby reducing the congestion of the geostationary orbit and allowing all nations greater flexibility in fulfilling their needs. Some delegations felt that the developing countries should rely on their own combined and co-operative efforts to gradually build up and strengthen their capabilities in space science and technology and to aid in solving the geostationary orbit problems. The view was expressed that a tax or levy should be applied to the use of the geostationary orbit. It was also suggested that removal of inactive satellites would reduce the risk of physical interference between satellites in the geostationary orbit.

519. Some delegations noted the great potential of direct television broadcasting from satellites for educational, medical and social purposes, especially for remote rural regions. Many countries felt that direct broadcasting from satellites should be undertaken in a manner compatible with sovereign rights and with the prior consent of the receiving State. Other delegations felt that the "spillover" provisions of the ITU Convention were sufficient in this regard. It was noted that direct television broadcasting might also be seen as a threat to the cultural integrity of the receiving States. The development of a code or set of principles regulating transnational transmissions by direct broadcasting satellites had preoccupied various bodies, including the United Nations General Assembly, ITU and UNESCO, but the dichotomy between free flow of information and prior consent had yet to be satisfactorily resolved: some countries insisted on the free flow of information across borders, while others insisted upon prior consent by the receiving State.

520. Several delegations noted that domestic and bilateral programmes using direct television broadcasting had already found successful applications and that several programmes for regional direct broadcasting by satellite were planned for the near

future. Many delegations felt, however, that international direct broadcasting should await such guiding principles as would be acceptable to all. The view was also expressed that the demands for protection of political and cultural integrity were not inconsistent with the established human right to transmit and receive information freely, regardless of frontiers.

521. Regarding the question of strengthening international space law, some delegations expressed the urgent need to supplement the 1967 Treaty on Outer Space and to elaborate norms aimed at banning the arms race from outer space. It was also suggested that additional norms should be elaborated covering particular areas of concern, such as remote sensing and direct television broadcasting. Other delegations expressed the view that existing international legal agreements covering space activities, in particular, the Convention and Regulations of the International Telecommunication Union (ITU) covering uses and applications of space technology, were sufficient.

522. During the course of the general debate, the potential danger implicit in the use of outer space for military purposes was mentioned with concern by most delegations, and the international community was urged to give urgent consideration to measures to ban an arms race in outer space. In this connexion, some delegations urged that negotiations be started within the Committee on Disarmament on the proposed treaty on the prohibition of stationing of weapons of any kind in outer space. While many delegations felt that the Committee on Disarmament was the most appropriate forum for discussing such concerns, others stated that the issue of the military uses of space should simultaneously be considered in COPUOS and in its Legal Sub-Committee. A few delegations expressed the view that the current Conference was an inappropriate forum for discussing the question. The view was also expressed that the responsibility for demilitarizing space rested with the two major space Powers.

523. Several delegations cited the need to negotiate an effective and verifiable agreement to prohibit anti-satellite systems. Some delegations stressed the need to resolve the problem of preventing the arms race in outer space as a whole. The view was also expressed that those space activities characterized as essentially defensive or as contributing to the avoidance of war should not be restricted, except in the context of some general or balanced disarmament programmes.

524. Many delegations felt that an arms race in space would be costly as well as dangerous, and it was noted that the redistribution of the vast resources denoted to military purposes could solve many pressing economic and social problems of the developing countries. Finally, the view was expressed that the banning of weapons of mass destruction from outer space was not enough; space technology must be actively used to promote peace.

525. During the general debate, numerous delegations denounced the wrongful use of space technology, such as surveillance satellites, in cases of military conflict, and condemned the aggression committed against Lebanon and the barbarous massacres committed against the Palestinian and Lebanese civilian populations by the aggressor in defiance of international law and morality, as well as the assistance provided to the aggressor in its expansionist policy.

526. Some countries announced a number of initiatives to bring broader benefits of space technology to other countries, particularly the developing countries. Those included, for instance, an initiative for long-term co-operative research efforts

on global habitability, projects for assisting all countries to better anticipate and cope with natural disasters, publication of an aid to obtaining valuable remote sensing data, an international conference on rural satellite communications, the development of a combined low-cost satellite ground station and photovoltaic power system optimized for developing country use, further study of the legal aspects of space activities, promotion of international space flights and increased research on the impact of extended space activities on the near earth environment. A developing country proposed the creation of a regional centre for space applications.

527. With respect to the role of the United Nations system in outer space matters, several countries, including developing and developed countries, called for a strengthening of that Organization's involvement in space activity. Some of them specifically stated their opinion that additional costs could be covered by the regular budget of the United Nations or within existing financial resources, while others urged increasing funding for United Nations space programmes through voluntary contributions from countries in a position to increase their support. The view was also expressed that funds for those programmes should also be sought through the existing channels of the United Nations for technical assistance, such as UNDP. Most countries expressed support for a United Nations co-ordinating role in space activities. The view was also expressed that increased funding through the United Nations system should be used to encourage developed countries' space projects in developing countries.

528. Some delegations proposed the creation of a new international agency for outer space, while others supported the establishment of a centre for outer space within the United Nations Secretariat. Several delegations stated that they saw no need for making any change in the existing United Nations framework; rather, they asked for a rationalization and better utilization of existing United Nations resources dealing with outer space. It was generally agreed that the United Nations should concentrate on programmes for the benefit of developing countries in the development and application of space science and technology, including the establishment of an international space information service.

529. Three of the specialized agencies of the United Nations were represented at the Conference and made statements in the course of the general debate. The Secretary-General of ITU said his organization, like UNISPACE 82, sought to heighten awareness of the potential benefits of space technology. It was concerned with activity at the governmental level in the areas of standardization and regulation and was carrying out certain technical co-operation activities in close collaboration with UNDP. The representative of FAO stated that remote sensing was already providing better understanding and more effective management of renewable resources, particularly in agriculture and forestry and might play an increasingly useful role in monitoring and anticipating natural disasters. The representative of UNESCO dwelt on the potential benefits which satellite communication could provide in the field of education, for which he suggested that certain guiding principles might be formulated which would ensure the free circulation of information to all countries.

530. Statements were also made in the course of the general debate by officials of other United Nations offices which played a role in space activities. The Deputy Executive Director of UNEP considered that it was time to give thought to a global resource data handling service and the dissemination of environmental data collected from space in a standardized and geographically-referenced form

compatible with data already available to countries. The Executive Director of UNIDO said that that organization had been engaged in a programme dealing with technological breakthroughs under which the potentials and implications of advances were being identified. The representative of the United Nations Centre for Science and Technology for Development noted the clear need for the international community to help developing countries build up their capacities in the use of space science and technology for development suited to their needs. The Vice-Rector of the United Nations University hoped that outer space would become a further dimension in the growth potential of the human race and that all mankind would reap its benefits.

531. Among the intergovernmental organizations taking part in the general debate, the Director-General of ESA underlined the exclusively peaceful purposes of that Agency's work in space research and technology and its range of co-operative agreements with many developed and developing countries. The representative of the European Community (EC) said that the Community's activities in space technology were related to the work undertaken at the national level by its members, concentrating on remote sensing and telecommunication. The representative of the Council of Europe said that his organization supported the development of European space programmes, and he endorsed the idea of an international satellite monitoring agency. The representative of the Council for Mutual Economic Assistance (CMEA) stressed the co-operative nature of the Council's work with centrally planned economies, with other developed countries and with developing countries, seeking practical results from each new experiment in space. The Secretary-General of the Pan-African Telecommunications Union (PATU) stated that his organization, in collaboration with ECA and with the assistance of other countries and international organizations, was studying the feasibility of a regional communication satellite system, AFROSAT, as part of a programme for the development and integration of the continent.

532. Non-governmental organizations involved with space research and technology whose representatives participated in the general debate included IAF and ICSU/COSPAR. Statements were also made by representatives of the International Association of Educators for World Peace, the Baha'i International Community and the Universal Esperanto Association, as well as by representatives of the United Nations Council for Namibia, the Afican National Congress of South Africa and the Pan-African Congress of Azania.

533. The Conference particularly examined a proposal to include as annexes to the present report documents A/CONF.101/5 and A/CONF.101/L.3 which contained the position of the Group of 77 concerning the arms race in outer space, direct television broadcasting and remote sensing. Due to the lack of consensus on that proposal, the Conference noted the concerns of the Group of 77 expressed in those documents.

## CHAPTER IV

## REPORTS OF SUBSIDIARY BODIES AND ACTION TAKEN ON THESE REPORTS BY THE CONFERENCE

### A. Report of the First Committee

534. The Conference, at its 1st plenary meeting, allocated to the First Committee item 9 of the agenda as follows:

State of space science and technology

(a) Review and projection of the current and future state of science and technology for space research and applications

(b) Evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far

535. The Conference requested that the Committee, in its consideration of that agenda item, consider the introduction and chapter I of the draft report of the Conference (A/CONF.101/3).

536. The First Committee met from 9 to 16 August 1982 and held nine meetings, including two meetings on Saturday, 14 August and one on Monday, 16 August 1982, which were added to the six meetings originally scheduled in order to allow the Committee to complete its work.

537. Mr. Robert Knuth (German Democratic Republic) was elected Chairman of the Committee by the Conference at its 1st plenary meeting.

538. The Committee, at its 1st meeting, elected the following other officers:

Vice Chairman: Mr. I. O. A. Lasode (Nigeria)

Rapporteur: Mr. Mahbub Uddin Chaudhury (Bangladesh)

At the same meeting the Committee decided to concentrate on detailed consideration of the introduction and chapter I of the draft report.

539. The Committee, at its 3rd meeting, established an informal working group to consider two paragraphs relating to the geostationary orbit. The working group held two meetings under the chairmanship of Mr. Soegihono Kadarisman (Indonesia) and reported to the Committee at its 5th and 7th meetings.

540. The Committee recommended to the Conference the adoption of the introduction and chapter I of the draft report of the Conference, as amended by the Committee and reproduced in the annex to its report.

541. The Committee was unable to reach agreement on paragraph 13 of the draft report, which was therefore referred to the Conference for consideration in plenary meeting.

## Action by the Conference

542. At the 13th plenary meeting, on 21 August, the Conference considered the report of the First Committee, which was introduced by its Chairman, in the absence of the Rapporteur.

543. The Conference took note of the report of the First Committee and adopted the text recommended by the Committee for inclusion in the final report of the Conference.

## B. Report of the Second Committee

544. The Conference, at its 1st plenary meeting, allocated to the Second Committee item 10 of the agenda as follows:

Applications of space science and technology

(a) Evaluation of the current and potential applications of space technology, taking into account present and foreseeable national and international programmes in the areas of space research

(b) Examination of the possibilities and mechanisms for enabling all States to benefit from space technology, bearing in mind their various levels of development, varying capacities to absorb new technologies and particular needs and priorities

(c) Examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard

(d) Examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measure to augment their capabilities to develop space technology and facilitate access to such technology and to participate and co-operate in space activities so as to derive maximum benefit from space technology and its applications

(e) Examination of developments and system configurations appropriate to the use of space technology for education

(f) Discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation

(g) Consideration of the implications of projected developments in the areas of space technology such as earth-orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end

(h) Discussion of the nature of, and ways of protecting, the near-earth environment including the upper atmosphere and magnetosphere

545. The Conference requested that the Committee, in its consideration of that agenda item, consider chapter II of the draft report of the Conference (A/CONF.101/3).

546. Mr. Minoru Oda (Japan) was elected Chairman of the Committee by the Conference at its 1st plenary meeting.

547. The Second Committee met from 12 to 19 August 1982 and held 11 meetings.

548. The Committee, at its 1st meeting, elected the following other officers:

Vice-Chairman: Mr. Miguel Sanchez Peña (Argentina)

Rapporteur: Mr. Ahmed Bensari (Morocco)

At the same meeting the Committee decided to consider chapter II of the draft report on a paragraph-by-paragraph basis.

549. The Committee discussed paragraphs 205 and 231 but was unable to reach agreement on paragraph 205 and part of paragraph 231, which it therefore decided to refer to the Conference for consideration in plenary meeting.

550. The Committee reached consensus on all paragraphs of chapter II, with the exception of paragraph 205 and part of paragraph 231 referred to above.

551. The Committee therefore recommended to the Conference the adoption of chapter II of the draft report of the Conference, as amended by the Committee and reproduced in the annex to its report.

### Action by the Conference

552. At the 13th plenary meeting, on 21 August, the Conference considered the report of the Second Committee, which was introduced by its Rapporteur. Attention was drawn to corrections to be made in the text submitted by the Committee.

553. The Conference took note of the report of the Second Committee and adopted the text recommended by it for inclusion in the final report of the Conference.

## C. Report of the Third Committee

554. The Conference, at its 1st plenary meeting, allocated to the Third Committee item 11 of the agenda as follows:

International co-operation and the role of the United Nations

(a) Consideration of reports on the nature and extent of the bilateral and multilateral co-operation in outer space activities

(b) Consideration of reports on the activities of the United Nations, including its specialized agencies, and of other international organizations dealing with the exploration and peaceful uses of outer space

(c) Evaluation of the role of the United Nations, its specialized agencies, other international organizations and programmes of bilateral and multilateral co-operation in order to ensure broad international co-operation on an equal basis

(d) Evaluation of the role of the United Nations in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role

555. The Conference requested that the Committee base its consideration of that agenda item on chapter III of the draft report of the Conference (A/CONF.101/3).

556. Mr. David K. Andero (Kenya) was elected Chairman of the Committee by the Conference at its 1st plenary meeting.

557. The Third Committee met from 13 to 19 August 1982 and held seven meetings.

558. The Committee, at its 1st meeting, elected the following other officers:

Vice-Chairman: Dr. Djordje Teleki (Yugoslavia)

Rapporteur: Mr. Karol van Kesteren (Netherlands)

559. The Committee, at its 1st meeting, decided to consider chapter III of the draft report on a paragraph-by-paragraph basis.

560. At its 4th meeting the Committee discussed paragraph 419 but was unable to reach agreement on it. It therefore decided to refer that paragraph to the Conference for consideration in plenary meeting.

561. At its 6th meeting the Committee established an informal working group to consider the last four paragraphs of chapter III, relating to the organizational set-up of the Outer Space Affairs Division of the United Nations. Mrs. Eva Nowotny (Austria) was elected to convene this working group, which held one meeting on 19 August. The working group reported to the Committee at its 7th meeting, on 19 August.

562. The Committee reached consensus on all paragraphs of chapter III, with the exception of paragraph 419, mentioned above.

563. The Committee therefore recommended to the Conference the adoption of chapter III of the draft report of the Conference, as amended by the Committee and reproduced in the annex to its report.

## Action by the Conference

564. At the 13th plenary meeting, on 21 August, the Conference considered the report of the Third Committee, which was introduced by Mr. Karel van Kesteren (Netherlands), the Rapporteur of the Committee. Attention was drawn to corrections to be made in the text submitted by the Committee.

565. The Conference took note of the report of the Third Committee and adopted the text recommended by it for inclusion in the final report of the Conference.

## D. Report of the Credentials Committee

566. At its 5th and 6th plenary meetings, held on 11 August 1982, the Conference, in accordance with rule 4 of its rules of procedure, appointed a Credentials Committee consisting of the following States: Algeria, Angola, Chile, China, Netherlands, Panama, Philippines, USSR and United States.

567. The Credentials Committee convened on 12 August 1982.

568. Mr. Domingo L. Siazon (Philippines) was unanimously elected Chairman.

569. The Committee had before it a memorandum dated 10 August 1982 from the Secretary-General of the Conference on the status, as at 10 August 1982, of credentials of the representatives to the Conference. The memorandum, as orally amended by the Legal Adviser during the meeting (see para. 570 below), indicted that:

(a) Credentials issued by the head of State or Government or by the minister for foreign affairs, as provided for in rule 3 of the rules of procedure of the Conference, had been received in respect of representatives of 63 States, namely: Albania, Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Bulgaria, Byelorussian SSR, Canada, Chile, China, Costa Rica, Cuba, Cyprus, Czechoslovakia, Denmark, Finland, France, Gabon, German Democratic Republic, Germany, Federal Republic of, Greece, Holy See, Hungary, India, Iran, Iraq, Ireland, Israel, Japan, Mexico, Mongolia, Morocco, Netherlands, New Zealand, Nigeria, Norway, Panama, Poland, Portugal, Republic of Korea, Romania, San Marino, Saudi Arabia, Senegal, Spain, Sri Lanka, Sudan, Sweden, Syrian Arab Republic, Thailand, Turkey, Uganda, Ukrainian SSR, USSR, United Kingdom, Upper Volta, Uruguay, Venezuela, Yugoslavia and Zimbabwe;

(b) Credentials in the form of a telegram from the head of State or Government or minister for foreign affairs had been received in respect of representatives of two States, namely: Luxembourg and Viet Nam;

(c) Credentials in the form of a letter, note verbale or telegram emanating from a permanent representative, an ambassador, a minister other than the minister for foreign affairs or from a permanent mission, embassy or ministry of the State concerned in respect of representatives of 24 States, namely: Algeria, Bolivia, Colombia, Democratic Yemen, Ecuador, Egypt, Guatemala, Indonesia, Italy, Kenya, Lebanon, Lesotho, Libyan Arab Jamahiriya, Malaysia, Pakistan, Peru, Philippines, Rwanda, Somalia, Switzerland, Tunisia, United Republic of Cameroon, United States and Zaire;

(d) As at 12 August 1982, representatives of 91 States had registered as participants in the Conference. No credentials had yet been received from the representatives of two States, namely: Mali and Qatar.

570. The Legal Adviser stated that since the preparation of the memorandum by the Secretary-General of the Conference, representatives of additional States had registered and some had submitted credentials. Accordingly, the Legal Adviser orally amended the memorandum to reflect the status as at the time of the meeting. The contents of the memorandum, as orally amended, are set out in the foregoing paragraph. The Legal Adviser further explained that the States listed in subparagraph (a) above had submitted credentials in the form required by rule 3 of

the rules of procedure of the Conference; the States mentioned in subparagraph (b) had submitted credentials in the form of telegrams emanating from the authorities referred to in rule 3, while the States mentioned in subparagraph (c) had issued credentials signed by authorities other than those referred to in rule 3; the States referred to in subparagraph (d) had registered delegates as participants in the Conference, but had not yet submitted any credentials. The Legal Adviser stated that the practice was to approve the credentials issued in the form required by rule 3, to approve provisionally those credentials which were not in proper form and to recommend to the Conference that the delegations that had not yet submitted credentials should be permitted to continue to participate in the Conference on the understanding that proper credentials would be submitted as soon as possible.

571. The representative of the USSR stated that his Government did not accept the credentials presented by the delegation of Chile, considering that those credentials had been issued by persons who had usurped power in that country.

572. The representative of Chile stated that he was surprised at the statement by the representative of the USSR, considering that since 1974 Chile and the USSR had been members of COPUOS and no similar problem had arisen. He considered that the Committee was not a political forum and that its task was to examine the form of the credentials.

573. On the proposal of the Chairman, the Committee unanimously adopted the following resolution:

"The Credentials Committee,

"Having examined the credentials of the representatives to the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, referred to in paragraph 4* of the present report,

"Taking into account the different reservations expressed by delegations during the debate,

"1. Accepts the credentials of the 63 States referred to in paragraph 4 (a) above;

"2. Accepts provisionally the communications relating to the representatives of the 26 States referred to in paragraphs 4 (b) and (c) above, pending the receipt of credentials complying with rule 3 of the rules of procedure;

"3. Recommends that the representatives of the two States referred to in paragraph 4 (d) above should continue to participate provisionally in the Conference in accordance with rule 5 of the rules of procedure, pending the receipt of credentials complying with rule 3."

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* Now reflected in paragraph 569 above.

574. The Committee also decided to authorize its Chairman to formulate the report of the Committee with the assistance of the Secretary and to submit the report to the Conference after having shown a draft thereof to the members of the Committee. The Chairman was further authorized to supplement, when introducing the report to the Conference, the information set out in paragraph 569 above so as to reflect any further registrations, credentials and communications received by the Secretary-General after the meeting of the Committee.

575. On the proposal of the Chairman, the Committee decided to recommend to the Conference the adoption of the following resolution:

> "The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space
>
> "Approves the report of the Credentials Committee."

## Action by the Conference

576. At the 12th plenary meeting, on 20 August, the Conference considered the report of the Credentials Committee.

577. The Chairman of the Committee announced that, since the date of the Committee's meeting, credentials in good and due form had been received from Indonesia, Italy, Pakistan and Switzerland and that credentials signed by authorities other than those referred to in rule 3 had been received from Benin and Kuwait. THe United Republic of Tanzania had registered delegates but had not yet submitted any credentials. The total number of States participating in the Conference was therefore 94.

578. After taking note of that supplementary information, the Conference approved the report of the Credentials Committee.

## CHAPTER V

## ADOPTION OF THE REPORT OF THE CONFERENCE

579. The Rapporteur-General introduced the draft report of the Conference (A/CONF.101/L.2 and Add.1) at the 12th plenary meeting, on 20 August 1982.

580. The Conference considered chapters I, II and III of part two of the draft report and adopted them with certain amendments.

581. At the 13th plenary meeting, on 21 August, an informal consultation group entitled "Friends of the President", which had been established to consider the paragraphs referred to the plenary by the three committees and which consisted of three countries from each geographical region, submitted proposed texts for three paragraphs to the Conference. The proposed texts were adopted by the Conference for inclusion into the decisions and recommendations of the Conference as paragraphs 13, 14 and 426.

582. At the same meeting, the representative of Brazil introduced a draft resolution expressing the Conference's gratitude to the host country. The Conference adopted the draft resolution by acclamation. The text of the resolution is reproduced in chapter VII below.

583. The Conference adopted the draft report as a whole and authorized the Rapporteur-General to complete it in conformity with United Nations practice, with a view to its submission to the General Assembly at its thirty-seventh session.

584. Following statements by the representatives of Egypt (on behalf of the African States), the Philippines (on behalf of the Asian States), the USSR (on behalf of the Eastern European States), Uruguay (on behalf of the Latin American States), New Zealand (on behalf of the Western European and other States) and Morocco (on behalf of the Arab States), the Secretary-General made a statement summing up the principal results of the Conference. The text of the Secretary-General's statement is reproduced in chapter VI below.

585. The President of the Conference made a closing statement and declared the Conference closed. The text of the President's statement is reproduced in chapter VI below.

## CHAPTER VI

## CONCLUDING STATEMENTS

### A. Statement by the Secretary-General of the Conference

586. After years of preparation, and two weeks of intensive work, of meetings and discussions, consultations and confabulations, negotiations and receptions, we are now at the end of our Conference. By general consensus this was a successful Conference. But what have we achieved?

587. I feel we have achieved a great deal. What is set out in our reports, is only a part - though an important part - of our achievement. In addition, the Conference has created a wide awareness - I hesitate to say a world-wide awareness - about capabilities of man in space technology and its applications and of the potential this holds for our future. The Conference has brought together scientists and statesmen, politicians and policy-makers from almost a hundred countries who have, I hope, developed a better understanding of the many multi-dimensional features of our subject and a great appreciation of each other's point of view. This understanding and the spirit of co-operation are manifest in the fact that all the three Committees have produced consensus reports dealing with topics which are at once complicated and simple. Such issues, you will agree, are often the most difficult to resolve, because concepts and facts are at play in the same arena. We have resolved many and agreed to continue discussing others. I hope that this co-operative, imaginative and business-like spirit of Vienna would be carried far beyond the walls of this beautiful building to all corners of the earth - and beyond, perhaps also into outer space.

588. We had no plans to build a large new administrative structure to further the ends of this Conference and, fortunately, we have not chosen such a simple and easy symbol to mark the success of our Conference. Instead, we have examined in some detail the problems of using space in different ways for the good of all mankind. Our suggestions and recommendations have specificity and yet they are grounded in the global and co-operative framework of man's space enterprise. We have recognized that beyond the adventure, beyond the urge to find out more about the cosmos, there is a whole new agenda here on the ground for various countries, individually and jointly, to ensure that this new happening in human history will have meaning for the largest number of people. We have emphasized that we must proceed, past our concern with widening existing highways, to building of new pathways into wilderness. Our reports recognize that in principle the benefits of space can descend on this earth to every man and woman as democratically as sunlight.

589. Of course, what we have adopted today is not a blueprint for the uplift of humankind, nor even a moderately exhaustive plan of action for future space activities. It could not have been, because we are still groping. Rather, I see our work as a partial road map into the future with many roads and avenues, and many destinations. It is for each country, individually and in co-operation, to decide its goals and to chart its own course to achieve these goals. Several recipes and guidelines are, however, clarified in our reports.

590. And yet there are some common imperatives of the space age. We have to move and prosper with each other and with our earth. We can no longer live off each

other nor can we merely exploit our earth. Our planet, and we ourselves, have, in a sense, become one organism because we influence each other and touch each other, ever so intimately, independent of distance. The time constant for interaction between segments of human society has become shorter than the response time of the human nervous system. We must move from being new neighbours to become neighbourly.

591. During an evening lecture a distinguished speaker wondered whether our venturing out into space is not in response to the basic urge of our gene material, DNA, to spread out into the universe. I hope that the exuberant selfish gene would also recognize that it should not be wiped out here on earth through the same means it has evolved for its expansion. We have expressed our concerns in this regard during this Conference. I hope that our expression will make a difference.

592. I have often been accused, by friends and colleagues, of introducing, according to them, extraneous, philosophic and aesthetic elements into our deliberations and documents. I plead guilty. We do have a new philosophic, aesthetic and simultaneously ethical input into our history. Without recognizing this, our directions might go astray. We have to combine our new technical virtuosity with a new awareness of our connectivity, with each other and with our planet. To a small measure the work of this great Conference makes such an attempt. I congratulate you Mr. President, distinguished delegates, for this achievement.

593. I would like to express my deep gratitude to you and - through you - to the Austrian Government for the excellent arrangements made for this Conference. The co-operation, help and efficiency of all who worked for this Conference have contributed centrally to the smooth functioning of the Conference. The hospitality of your countrymen is of course proverbial and I assure you that we have been made to feel like pampered guests throughout our stay here.

594. Finally, I offer thanks to the staff of my own organization, the United Nations, my distinguished colleagues in the Secretariat, particularly the hard-working and indispensable Executive Secretary, and the offices of the United Nations in Vienna and in New York. Without the devotion and hard work of everyone concerned - the conference officers and interpreters who worked here in the conference hall and in New York, those concerned with production and distribution of documents, the translators both here and in New York and a host of others - we could not have carried out our work as we did.

## B. Statement by the President of the Conference

595. After two weeks of intensive work, we are now at the close of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. Coming as it did a full 14 years after the first Conference, this was by itself a momentous event. But it has assumed far greater importance because of the very rapid progress made in space technology in the intervening years: progress that has drastically altered the possibilities that space technology offers. It has now assumed the form of an important and powerful tool for accelerating economic development, promoting education and communication, and monitoring the well-being of our environment. Equally importantly, the excitement and daring exploits of man in space - through astronauts, cosmonauts and spationauts, as well as through robot vehicles - have fired the imagination and expectations of people everywhere. I

stress expectations, because countries now look to space technology, and therefore to this Conference also, to come up with ways and means of bettering the quality of life.

596. It is in the context of this backdrop that one must view our endeavours over the last two weeks. Have we succeeded in fulfilling the hopes of peoples around the world? Has our Conference created a path or least indicated a direction by which all humanity can share the fruits of these new exploits of man?

597. Personally, looking upon our deliberations here and at the final output - namely, the reports of the three Main Committees - I am indeed gratified by what we have been able to achieve. The recommendations for concrete action, though they may at first seem modest, are well thought-out steps that should set the pattern for a more co-operative and equitable sharing of the benefits from space. They also aim at strengthening indigenous capabilities and developing human resources, which - in the final analysis - is our greatest resource and one that is "renewable".

598. I am also happy about another aspect: the reports of all the three Main Committees were finalized on the basis of consensus. This, I feel, augurs well for future co-operation in this field. I would sincerely hope that this spirit of accommodation, of compromise and co-operation is carried to the day-to-day dealings between our various nations in all fields.

599. However, my happiness about our proceedings is somewhat dampened by the fact that our co-operation here is parallelled by an unprecedented effort to develop and even deploy weapons that would threaten peace in space. While we have successfully incorporated our concerns about this in the report - and for this I am most grateful for the co-operation extended by various delegations in my efforts - I am unfortunately not sure whether these concerns will have an impact on the reality of what is happening. However, I do hope that this Conference, by stressing the peaceful uses of space, by highlighting the need for co-operation as a pre-requisite to mutual benefits, will create a world-wide awareness of the need to ensure that outer space remains a peaceful environment - one that is free of weapons and one in which all peaceful activity is inviolable.

600. The positive achievement of this Conference has been substantial and for this the credit goes to all of you. We should, however, also remember the tremendous efforts made by our distinguished Secretary-General as well as by the Executive Secretary and by the staff of the United Nations, both in the preparations for this Conference and in its smooth functioning. It is also with sincere gratitude that I would like to mention the excellent support that I have received from my colleagues in the Bureau of the Conference, including our distinguished Rapporteur-General and the Vice-Presidents, as well as the Chairman of the three Committees and other officers of the Conference.

601. I hesitate to mention a fellow-countryman, but in all fairness I must recall the very excellent work done by Ambassador Jankowitsch as Chairman of the Preparatory Committee and indeed by the whole Committee.

602. I hope that in addition to your work in the Conference, you were able to spend a little time looking at our city. I hope our efforts to make your stay here as comfortable and enjoyable as possible were fruitful.

603. I wish you all a very pleasant and comfortable journey back to your homes.

604. I now declare closed the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

## CHAPTER VII

## RESOLUTION ADOPTED BY THE CONFERENCE

605. At its 13th (closing) plenary meeting, on 21 August 1982, the Conference adopted the following resolution:

### EXPRESSION OF GRATITUDE TO THE HOST COUNTRY

"*The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space*,

"*Having met* at the Hofburg Congress Centre in Vienna from 9 to 20/21 August 1982, in response to the invitation of the Government of Austria,

"1. *Expresses* its deep appreciation to the Government of Austria for its generosity in hosting the Conference in a splendid manner, and for the kindness and efficiency of the Austrian personnel that made the necessary arrangements for and assisted during the work of the Conference, which contributed greatly to its success;

"2. *Expresses* its profound gratitude to the Austrian authorities responsible for the many special arrangements associated with the work of the Conference in connexion with the technical presentations, space demonstrations, exhibitions, poster sessions, forums and lectures that enhanced the work of the Conference;

"3. *Extends* its thanks to the Government and people of Austria, as well as to the authorities and people of Vienna, who have been so hospitable to the participants in the Conference."

## CHAPTER VIII

## ACTIVITIES ASSOCIATED WITH THE CONFERENCE

606. During and prior to UNISPACE 82, a number of special events were organized which provided an opportunity for States, intergovernmental and non-governmental organizations and private interests to present information or demonstrations relating to their interests or accomplishments in the field of outer space activities and to promote greater awareness about the use and potential of space technology.

607. The various activities included: (a) space demonstrations, (b) technical presentations and poster sessions, (c) evening lectures, (d) a forum organized by COSPAR and IAF, (e) exhibitions, (f) activities arranged by and for non-governmental organizations and (g) preparatory and public awareness activities.

608. Each of these activities is described in the following paragraphs.

### A. Demonstrations of space applications

609. With the objective of bringing to the Conference some glimpses of the actual applications of space technology in a variety of situations, the Conference secretariat - in co-operation with a number of countries and organizations - arranged a number of demonstrations of space technology. For this purpose, a special large screen and associated projection arrangements were made in the plenary hall, where most of the demonstrations were watched "live" by the delegates.

610. The live demonstrations in the plenary meetings were about 10 minutes long and were generally shown at the beginning of the morning and afternoon meetings during the first week of the Conference. They included: satellite educational television broadcasting; scientific consultations via satellite; remote medical services via satellite; reception and processing of remote sensing data; reception and dissemination of meteorological data; maritime communication and navigation; and video-conferencing (one-way), including addresses by heads of State.

611. Other demonstrations were conducted for the entire two-week period using partly live and partly taped material. These were located in the Seitengalerie, outside the main conference room, and were available for observation or consultation by participants. These demonstrations included world-wide access to technical and scientific data banks, news reports from major press agencies via satellite, and a solar-powered satellite ground station. In addition, satellites were used in direct support of the Conference to provide remote interpretation and remote translation.

612. To facilitate these demonstrations, 18 satellites and 39 ground stations around the world were used. This was made possible only by the application of up-to-date management techniques and the support received from Member States, international organizations and the Austrian authorities. The demonstrations are briefly described in the following paragraphs.

### 1. Satellite educational television broadcasting

613. Broadcasting satellites have a unique ability to provide television programmes to large areas that are sparsely populated and difficult to reach. One demonstration showed such educational television broadcasting to rural areas of India.

614. Educational television programmes that were broadcast by the NASA ATS-6 satellite to 2,400 villages in India were shown, and the results of the Satellite Instructional Television Experiment (SITE), which had been conducted in 1975/76 were discussed. It had included basic science programmes for students of 6 to 12 years of age, enrichment courses in science and mathematics to teachers during vacation periods and general educational programming to village adults in the evening. The experience from this experiment is being used in the establishment of the Indian National Satellite (INSAT) system, of which the first satellite was launched earlier this year.

615. The transmission was relayed from New Delhi via Fucino, Italy, using an INTELSAT satellite and the OTS satellite developed by ESA.

### 2. Scientific consultations via satellite

616. Three satellites, PALAPA, INTELSAT and OTS, were used to relay a transmission between two Indonesian universities via Jakarta and Fucino, Italy. What was demonstrated is how a university, confronted with a particular scientific problem (in this case pollution) is able to seek support from specialists in another university via the PALAPA satellite system. "Live" interaction with the Conference - through replies to questions asked from Vienna - was also included.

### 3. Remote medical services

617. Satellite technology can assist in providing to rural areas medical services that require specialist consultation. This demonstration showed the use of the Canadian Anik-B satellite to permit health practitioners in remote villages in north-eastern Canada to transmit electro-cardiograph, electro-encephalograph and X-ray data to an expert at Memorial University in St. John's, Newfoundland.

618. In addition to using Anik-B, the demonstration used the OTS satellite to relay the transmission to Vienna. Again, interaction with the Conference was also included, through a dialogue.

### 4. Reception and processing of remote sensing data

619. The value of satellite remote sensing for surveying earth resources has been clearly demonstrated, but applications have been limited by difficulties and delays in obtaining data. This is particularly important in areas such as agriculture and hydrology where rapid access to data is essential. A means of ensuring rapid access to satellite data would be the establishment of a world-wide data distribution system using communication satellites.

620. For immediate access to data, a "quick look" system can be used to relay data in semi-processed form as it is received from the satellite. This was demonstrated by relay of data from the NASA LANDSAT to the ESA ground station network (Earthnet) to Vienna via the OTS satellite.

621. A demonstration of interactive digital image processing was also included, using the German Aerospace Research Establishment (DFVLR) digital interactive image analysis system (DIBIAS) at Oberpfaffenhofen via the OTS satellite. Processing of data from the NASA Heat Capacity Mapping Mission (HCMM) satellite and the NIMBUS-7 coastal zone colour scanner (CZCS) was demonstrated.

## 5. Reception and dissemination of meteorological data

622. Meteorological satellite data are routinely used throughout the world for weather forecasting. This has been based on the availability of low-cost ground stations and free access to data transmissions from meteorological satellites.

623. Images from the NASA GOES-East and GOES-West satellites and from the ESA METEOSAT-2 were received by a Secondary Data Users Station (SDUS) at the Conference site and displayed. METEOSAT data were received directly from the satellite, while the GOES data were received and reformatted at a ground station in Lannion, France, and relayed via METEOSAT to Vienna.

624. In addition, an APT terminal received and displayed images from the United States NOAA satellites and the Soviet Union's METEOR satellites.

## 6. Maritime communication and navigation

625. INMARSAT became operational in 1982, linking coastal earth stations with ships and off-shore installations throughout the world, for both routine and emergency communications by telephone or telex.

626. To demonstrate this service, a ship-type terminal was installed at the Conference site in Vienna, enabling the Conference to communicate with ships at sea via coastal earth stations at Goonhilly (United Kingdom), Eik (Norway), Southbury (United States) and Yamaguchi (Japan).

## 7. Video-conferencing

627. Communication satellite technology allows groups of people to communicate, both by voice and visually, without leaving their offices. This was demonstrated by live addresses to the Conference by the heads of State of Brazil and Sri Lanka, speaking from their own capitals.

628. In addition, the Soviet cosmonauts aboard the Soviet Salyut-7 were shown in their spacecraft in orbit and spoke to the Conference. The signals were relayed from the Dubna earth station near Moscow via the Soviet Union Statsionar-4 satellite to the MOSKVA earth station in Vienna.

### 8. Remote conference services

629. Through the use of communication satellites, conference services - including simultaneous interpretation of meetings and translation of documents - can be provided from remote locations permitting the most efficient use of personnel and facilities. Communication satellites can provide links for voice, video, text and facsimile transmission.

630. For these purposes, a satellite earth station installed by COMSTAT at United Nations Headquarters in New York was used to communicate via an INTELSAT satellite with an earth station at the Conference site.

631. Simultaneous interpretation into the six official languages of the Conference was also done experimentally from New York using six language channels, two control channels and a video channel. This was done for two meetings of the plenary.

632. The translation of Conference documents was done operationally from New York for the entire Conference. A major advantage of this system was that documents were transmitted from Vienna to New York at the end of the working day and translated in New York during regular working hours due to the six-hour time difference. The translated documents were transmitted back to Vienna in time for the morning meetings the next day.

### 9. World-wide access to technical and scientific data banks

633. With modern communication systems, an inexpensive desk-top computer can link any user with any data bank. Some of these terminals were available at the Conference site to provide access to the following computer data banks:

(a) Informational Retrieval System (IRS), Frascati, Italy;

(b) National Technical Information Service (NTIS), Washington, D.C., United States;

(c) NASA/GSFC Get Away Special (GAS), Greenbelt, Maryland, United States;

(d) NASA/JSC Payload Integration Library System (PILS), Houston, Texas, United States.

634. The terminal in Vienna communicated via TELENET with the data banks in the United States and via ESA-Quest with several data banks located in the ESA member States. Radio Austria provided the essential local access to these networks via RADAUS NODE. High-density digital data was relayed back from the relevant data bank to Vienna via the OTS satellite.

### 10. News reports

635. News headlines from around the world were displayed on video units and teleprinters located outside the main conference room. INTELSAT, OTS and INTERSPUTNIK satellites were used to provide access to reports from Reuters, Agence France Presse (AFP), Inter Press Service (IPS), and TASS.

### 11. Solar-powered satellite earth station

636. Both applications and "spin-offs" of space technology were demonstrated by means of a satellite earth station powered by photovoltaic solar panels which also powered a water pump.

637. The system was developed by the solar energy projects branch at the NASA Lewis Research Centre together with the Bureau of Science and Technology/Office of Education of the United States Agency for International Development.

### 12. Applications of space technology

638. A "live" transmission from the USSR described the various applications of space technology as used in the Soviet Union. This programme was routed from the Soviet Union to Vienna in the same way as the programme from Salyut-7.

## B. Technical presentations and poster sessions

639. At the request of some of the specialized agencies and in order to enhance the technical content of the Conference, a series of technical presentations were organized on 13 August. The agencies concerned and the topics were as follows:

ITU/CCIR: The application of space telecommunications for development (Mr. R. E. Butler)

UNDRO: Satellite applications to disaster management (Mr. L. Walter)

FAO: Remote sensing applied to renewable resources - FAO's role and activities to assist developing countries (Dr. J. A. Howard)

UNEP: Remote sensing policy implications for bio-mass development (seminar chaired by Dr. Noel Brown; other speakers: Dr. Pincas Jawetz, Prof. Harbons Arora, Dr. Michael Gwynne)

ESA: The ESA remote sensing satellite ERS-1 (Dr. D. Lennertz)

In addition to the above, INMARSAT presented a film "Linked - via INMARSAT".

640. Apart from the technical presentations, "poster sessions" were organized to enable interested participants to present technical aspects of national papers and papers presented by participating organizations in the Conference. The following poster sessions were held:

10 August - "Global habitability" - Presenter: Shelby Tilford, NASA Director of Environmental Observations, and Richard Goody of Harvard University (United States)

- "Rural Satellite Program" - Presenter: Ms. Anna Stahmer, AID Rural Satellite Program (United States)

16 August - "Communication Satellite Technology" - Presenter: Dr. Hall Himball (United States)

- "Current Status of LANDSAT 4 Thematic Mapper Imagery and new Landsat Data Indexes" - Presenter: Dr. Vincent Salomonson (United States)

17 August - "Space Activities in China" - Film Presentation (China)

- "Space Telescope" - Presenter: Dr. Ricardo Giacconni, Johns Hopkins University (United States)

20 August - "Canada in Space" - Film presentation (Canada)

641. On 12 August, an International Astronomy Seminar was organized jointly by the United Nations and the International Astronomical Union. The programme included the following presentations:

The Sun and sunlike stars: Prof. M. K. V. Bappu (India)

Solar-terrestrial influences: Prof. R. M. Bonnet (France)

The size, shape and temperature of stars: Prof. R. Hanbury Brown (Australia)

X-ray and gamma-ray astronomy, new windows into our universe: Prof. W. H. G. Lewin (United States)

Space science and cosmology: Prof. M. S. Longair (United Kingdom)

Summary and concluding remarks: Prof. A. G. Massevitch (USSR)

## C. Evening lectures

642. The UNISPACE 82 secretariat organized three evening lectures by internationally eminent personalities - Arthur Clarke, Chancellor of the University of Moratuwa in Sri Lanka; Carl Sagan, Director of the Laboratory for Planetary Studies and Professor of Astronomy and Space Sciences at Cornell University in Ithaca, New York; and Oleg Gazenko, Director of the Institute of Biomedical Problems of the USSR Ministry of Health.

643. The broad purpose of the lectures was to give the audience, including the participants to UNISPACE 82 and the general public, a look at space from different perspectives. The lectures covered the practical benefits available from space and also the larger philosophical issues that space encompasses.

644. Arthur Clarke spoke on 10 August on "Space flight - imagination and reality"; Carl Sagan on 12 August on "The exploration of the solar system - retrospect and prospect"; and Oleg Gazenko on 17 August on "Man in space - space exploration from the biological point of view".

## D. Background papers

645. A number of background papers were prepared for the information of Member States and as an aid to their preparations for UNISPACE 82. They involved the participation of over 200 scientists, engineers and others from all over the world. Recognizing their long-term value and also in order to make them more widely available, the Conference secretariat arranged to have them published in the form of a book entitled The World in Space (publisher: Prentice Hall). The book was released just before the Conference.

## E. Regional and interregional seminars

646. Six regional and interregional seminars were held on space applications and oriented specially towards discussing issues related to UNISPACE 82. Four seminars were held in 1981, in Addis Ababa, Buenos Aires, Toulouse and Djakarta, and the other two were held in 1982 in Quito and Addis Ababa. A summary of the recommendations of those seminars was compiled and circulated to participants in UNISPACE 82 (A/CONF.101/BP/13).

## F. Other seminars and meetings

647. At the initiative and behest of the Conference secretariat, a number of seminars and meetings were arranged by various organizations to discuss matters related to the concerns of UNISPACE 82. Among those was a special symposium on the role and impact of space research in developing countries (organized jointly by COSPAR, COSTED and the United Nations in conjunction with the COSPAR meeting in Ottawa in May 1982) and a Stanley Foundation meeting in June 1982 on maintaining peace in outer space. Copies of the report of the latter meeting were made available at the time of the Conference. The Stockholm International Peace Research Institute (SIPRI) had also organized a meeting in Stockholm in November 1981 on "Outer space - a new dimension of the arms race" and a book based on this meeting was made available by SIPRI to delegations at UNISPACE 82. In

March 1982, the Conference secretariat - with financial assistance from the Government of Japan - had organized an international round table on "Alternative space futures and the human condition". A book based on the discussions has been published and was released just before the start of UNISPACE 82.

## G. Essay and poster contests

648. In order to promote greater interest and awareness about space technology in general, and UNISPACE in particular, two international contests were organized. One was an essay contest for school children on the theme "How space technology can transform my country and the world", the other was an international poster contest, with the winning entry to be the official poster for UNISPACE 82. The response to both contests was very enthusiastic and large numbers of entries were received. An exhibition of the winning national posters was organized during the Conference just outside the plenary hall. The winning essays from each region were printed (in the original language and with an English translation) and copies were made available to participants in the Conference. Three of the five regional winners, at the request of the Conference secretariat, had provided tapes (two video and one audio) in which they read out excerpts or spoke about their essays. These were played in the plenary hall during the Conference.

## H. Other public awareness activities

649. A special booklet was published by the United Nations which described the benefits of outer space, derived through various applications, and the role of the United Nations in space. Special postage stamps to commemorate UNISPACE 82 were also issued, along with a brochure that very briefly described the uses of space. Many other countries also issued special postage stamps.

650. Five issues of a newsletter - UNISPACE 82 News - were put out by the Conference secretariat. They included information on various UNISPACE-related activites as well as articles in Arabic, French, Russian and Spanish, though the basic language used for most articles was English.

## I. Exhibitions

651. In order to promote greater public awareness about space technology, and especially about its practical uses, the Conference secretariat organized - with the help and co-operation of the concerned Member States and organizations - a series of exhibitions at United Nations Headquarters in New York from February to July 1982. The common theme was "The use of space technology for the solution of earth-bound problems". Six separate exhibitions on that theme were organized, for about a month each, as follows:

February: International Civil Aviation Organization
March: India
April: European Space Agency
May: Indonesia
June: Japan
July: USSR

652. The exhibitions consisted basically of photographs, displays and descriptive material, along with a few models.

653. In Vienna, in conjunction with the Conference, the Government of Austria organized a major exhibition from 9 to 21 August. The exhibition was inaugurated on 9 August by Prof. Yash Pal, Secretary-General of UNISPACE 82. Twenty-five countries and four international organizations took part in that exhibition, which included a large number of models and a very extensive display of space technology, including equipment for space and ground use, and applications. Participating countries and organizations included: Austria, Belgiun, Bulgaria, Canada, Cuba, Czechoslovakia, Denmark, France, German Democratic Republic, Germany, Federal Republic of, Hungary, India, Italy, Japan, Kenya, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, USSR and United States; ESA, EUTELSAT, FAO and INTELSAT.

## J. COSPAR/IAF Forum

654. At the initiative of the Secretary-General of UNISPACE 82 and the Conference secretariat, COSPAR and IAF organized a UNISPACE forum in Vienna from 4 to 6 August 1982. The primary purpose was to provide an elaboration of the background papers for the Conference (in the preparation of which these two organizations had played an important role) and to provide a forum for discussions on matters related to the agenda of UNISPACE 82. The Forum was opened by Dr. Hertha Firnberg, Austrian Federal Minister for Science and Technology, and had as its co-chairmen Prof. J. H. Carver (Australia) and Prof. J. Ortner (Austria). Its programme included sessions on the following topics:

(a) Relevance of space science for development

(b) Remote sensing: meteorology, climatology, oceanography

(c) Remote sensing: agriculture, geology, geodesy

(d) Communications: educational uses of communication satellites

(e) Communications satellites: point-to-point, "commerical uses"

(f) Social and economic implications

(g) Management of space: communication frequencies, interactions of space objects

(h) Future space programmes of interest to developing countries.

655. A total of 184 persons from 42 countries participated in the Forum. A highlight was the last session, a round-table discussion in which heads or very senior representatives of nine space or space-related agencies took part. The report of the Forum was circulated to participants in UNISPACE 82 in the form of a background paper, as document A/CONF.101/BP/14.

## K. Activities of non-governmental organizations

656. Apart from the activities of the non-governmental organizations organized by COSPAR, IAF and IAU - already mentioned in earlier sections - a group of other non-governmental organizations, called "NGOs at UNISPACE", organized a number of

meetings and discussions throughout the duration of the Conference. This series of meetings was inaugurated by Prof. Yash Pal, Secretary-General of UNISPACE 82, on 9 August.

657. The programme of meetings and the names of the co-ordinators were as follows:

| | | Session co-ordinators |
|---|---|---|
| August 10 | Impact of space on the third world | Dr. Rashmi Mayur |
| August 11 | Energy from space | Dr. Peter Glaser |
| August 12 | Space, bioresources and the environment | Mr. Noel Brown<br>Mr. Pincas Jawetz |
| | Energy from space | Dr. Peter Glaser |
| August 13 | The private sector: key to the development of space | Dr. Klaus Heiss |
| August 14 | Preserving peace in space | Dr. Robert Bowman |
| August 16 | Future developments in space | Dr. David Webb |
| August 17 | Information from space | |
| August 18 | Biomedical aspects of space | Dr. William Douglas |
| August 19 | Legal/political aspects of space | Hon. Edward Finch, Esq. |
| August 20 | Scientific exploration of space | |
| | Philosophical aspects of space | Dr. Vanessa Merchant |
| August 21 | Closing session | |

## Notes

1/ See Report of the United Nations Conference on Science and Technology for Development, Vienna, 20-31 August 1979 (United Nations publication, Sales No. E.79.I.21 and corrigenda), chap. VII, paras. 1-7 of the Preamble.

2/ See Official Records of the General Assembly, Thirty-fourth Session, Supplement No. 20 (A/34/20), paras. 79-115.

3/ Ibid., Thirty-fifth Session, Supplement No. 46 (A/36/46).

## Annex I

## MESSAGES FROM HEADS OF STATE OR GOVERNMENT

### SRI LANKA

### Mr. J. R. Jayawarada, President

[Original: English]

I send you greetings on the inauguration of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. I send you also, on behalf of all Asians, our warm good wishes for the success of your deliberations in establishing outer space for all time, as mankind's new frontier to be explored and utilized in the interests of humanity.

It is a signal honour to my country, Sri Lanka, that I have been given this opportunity of representing our region in this inaugural broadcast, appropriately via space satellite. I speak, however, not only as an Asian but as a citizen of our planet.

You are meeting in the twenty-fifth year since the first satellite heralded the space age. Man has since taken his first step on the moon. Two great countries which pioneered space exploration have symbolized the essential unity of the human race by the linking of hands in space. Space technology has taken tremendous strides in the form of unmanned probes to distant planets and the development of reusable space vehicles. Man's knowledge of space does indeed literally and metaphorically encompass a much wider horizon today than it did a quarter century ago. The purpose of this Conference, to my mind, is to ensure that man's understanding of his place in our universe is also commensurate with his knowledge and his skill.

When the first conference on space met in historic Vienna 15 years ago the subject of outer space was, to many of us, particularly in the third world, somewhat distant. It was not, I must hasten to add, for lack of interest. We had too many concerns, too many immediate preoccupations here on earth. People who awakened to every dawning day as a day of anxiety about the family's next meal or about the health of a loved one, or about a roof over their heads to protect them from the elements on earth, could not become partners in this new area of human endeavour about which they had little knowledge.

What might be called the physical conquest of space has added a new dimension to our outlook on life on earth. That single small step on th moon was indeed a giant leap for mankind. In the last two decades the entire world community, developed and developing alike, has come into direct physical contact with the promise as well as the problems presented by man's conquest of space.

You are gathered in Vienna at this Confernece significantly designated as UNISPACE 1982, mandated to promote international co-operation in the exploration of outer space and its uses. This getting together, I woud presume, is not merely for the sharing of knowledge. From his earliest days, civilized man has sought knowledge and shared it through communication. Knowledge is no doubt a desirable end in itself. If it did not, however, result in improving the quality of human life, all knowledge would be barren and all science would be bereft of any meaning to billions of people on earth.

This Conference, I would venture to stress, should be about knowledge in the service of man, about knowledge with understanding. I would wish that the world community could look upon these last two decades of the twentieth century as the end of the era of narrow national rivalries and the beginning of an era of true human interdependence. That interdependence must surely mean that the knowledge of outer space and its potential, accumulated by the international community in the last two and a half decades, is viewed as a pool of human experience, as a tool to be employed in the improvement of people's lives everywhere.

In that vision of international life, the poorer nations which have not directly participated in or directly contributed to the conquest of space cannot remain outsiders, they cannot remain mere spectators of this great adventure which is unfolding before mankind. It is indeed being recognized, although unfortunately not widely enough, that these nations are not really outsiders. As partners in the global economic system, which enabled some nations to advance by leaps and bounds, these poorer nations themselves have contributed to that advance through that partnership. More directly individual scientists and technologists from the developing world have also contributed to the development of the technologies and the mastery of the skills which made space exploration possible.

The developing countries will not be satisfied with remaining mere spectators to the march of progress in space science and space technology. Quite many of them have their own programmes - some highly advanced and some only incipient - in the use and development of space science and space technology. Sri Lanka is no exception. We are committed partners in international co-operation in the use of space communications. We are, however, like many other nations in the third world, only in the initial stages of the use of space technology as we are in many other areas of basic science.

At the same time, like the other developing nations we do not intend to remain at that level. That is why I am happy to have seen the fruition last year of my objective of establishing in Colombo an institute of fundamental studies. The institute will develop before long as a meeting ground of world scientists of repute, who will pool their scientific knowledge and methods not only in the more conventional investigations in physics, chemistry, biology and astronomy but also in serious inquiry into philosophical questions such as the Buddha's view of the physical universe. We consider this Conference very important and very opportune. The importance which Sri Lanka attaches to it is reflected in the high level delegation which is in Vienna to join you in your work.

The development of space science holds not only positive promise. All of us are aware of its pitfalls as well. The potential of satellite technology for destructive uses is the greatest challenge which humanity faces today. We have the word of every astronaut and cosmonaut who looked at planet earth from space, that their first response to this view of our planet was a profound realization not only of its smallness in the vastness of the universe, but also of the oneness of the human condition. The greatest irony of our time is that even with that perception of our human bond, nations could think in terms of using that very same space to deny that bond. It would be man's greatest injustice to man, man's greatest insult to science to view outer space as another arena of conflict, another medium of mutual destruction. On behalf of all the peoples of our world and in the name of all humanity I voice our profound hope that this Conference will succeed in averting that folly.

This Conference presents us with a unique opportunity of strengthening the foundations of human interdependence, of sustaining in action all the noble ideals of all our religions, all our philosophies, all our civilizations. Let us grasp that opportunity of ensuring for our succeeding generations a world in which misunderstandings have been overcome and man is not only the master of his resources but also of his passions. It is our expectation that UNISPACE 1982 will mark the beginning of true interdependence among nations, trust and concord among peoples and peace on our planet.

## BRAZIL

### Mr. Joao Baptista de Oliveira Figueiredo, President

[Original: English]

The task to which you will be dedicated constitues, literally, the leading edge of human activity. Throughout the history of mankind the contemplation of space has given us matter for religious reflection and has enriched the memory of peoples with celestial myths. It fed the ideas of the first mathematicians and oriented the course of adventurous spirits who went to sea guided by the constant stars. It gave administrators the notion that seasons were associated with the movement of celestial bodies, helping them in the work of sowing and reaping which represented life to their peoples.

Centuries went by and human knowledge expanded enormously. Regarding space, however, our progress was bound to earth, and fenced in by its atmosphere. Exceptional minds applied themselves to the problems of the cosmos and, although limited by the data obtained with optical instruments, transformed our conception of the universe. But they could never take their instruments higher than the mountain peaks and the very air which gives us light filtered and deformed the fruits of their observations. In our time, after the pioneer advances of radioastronomy, the situation has changed radically. The last three decades have seen the birth of a complex and multidisciplinary space science in which are meshed physics and molecular biology, medicine and navigation, metal working and the study of electromagnetic propagation, the ecology of celestial bodies and the chemistry of combustion, all of which and many others comprising an interdependent whole.

This new knowledge and these new techniques already have important effects on our societies. The consiousness that we are all being affected by the first steps of man in space brought to Vienna, 14 years ago, the international community and today brings it together again, at the same place, to evaluate the developments since the first space Conference - to call it by its short name - and to endeavour to trace the future course of international co-operation in the exploration and use of outer space. Great advances have been recorded from 1968 to this date, most of which resulted from the efforts of the more prosperous countries, who are better equipped in science and technology. Other countries, and Brazil is among them, although suffering from the limitations imposed on them by their stage of development, have achieved positive even if more modest results in space science and its applications.

I shall not discourse on the work Brazil has been doing in the field of space. The Brazilian national paper, which was distributed to participants in the Conference, contains a description of our activities. I would like to reiterate, however, what representatives of the Brazilian Government have already said on several occasions, that is to say, that we are firmly disposed to co-operate with all countries - and particularly with developing countries - on all aspects of space science and utilization which may be within our reach and to mention Brazilian experience in remote sensing, satellite communications, computer science for space applications, astrophysics and meteorology as some of the several fields of possible co-operation between Brazil and other countries.

I have referred, although extremely briefly, to the new world of science and technology which space activities are opening to all of us. May I be allowed to say to you that, by the very importance of the subject of this Conference, it cannot be seen or treated in isolation, as a matter for the laboratory, the university or the research institute. Much less can the means of information, communication and for the expansion of knowledge under examination here be the object of a technical discussion detached from the economic, social and political facts of our planet. Nothing will contain a greater element of risk than to pretend that science exists in the abstract, with no influence on human relations or without being influenced by them. The main working document of the Conference touches lightly upon these aspects which I would call political and mentions, in an even more concise fashion, the work which is being done on these questions by the Committee on the Peaceful Uses of Outer Space of the United Nations. Those who follow the activities of the Committee are well aware of the Brazilian stand on those themes. Even so, I believe it necessary to remind the Conference of the importance of some among them and of how they transcend the frontiers of scientific and technological concerns, reaching the core itself of our conceptions of what is the state.

I will mention, first, remote sensing of the earth by means of satellites. This marvellous instrument offers to us a previously impossible knowledge of our natural resources, bringing to our eyes an unprecedented vision of the existence of minerals, of the growth of crops, of the good or bad utilization of forests, of maritime currents and air masses which affect our lives and our subsistence, of the effects of pollution and of urban growth presenting us, in sum, with an almost unlimited variety of useful and important information for a better organized and more productive life. At the same time, this multiple tool affects traditional concepts of security, violating the notion of national privacy and even, as indicatred in your working document, marching towards the violation of individual privacy. Remote sensing impinges on the sovereignty of States over their natural resources and it may prejudice the capacity of countries of negotiating the sale of their agricultural products at fair and equitable prices. This is an instrument both valuable and dangerous. I leave to the reflection of the Conference the necessity of establishment of principles to regulate its use.

The second point of concern to which I ask your attention is that of direct television broadcasting by satellites. This space activity is on the way of becoming reality, offering to the peoples of the earth matchless opportunities for mutual knowledge, cultural expansion and varied leisure. It brings, on the other hand, the threat of cultural aggression, of the transfer of habits and behaviour inappropriate to national realities, in addition to other potentialities which need not be mentioned at this moment. It is possible that in the future all mankind will speak one single language and have the same usages and it is also possible that this will contribute to peace among men. Today, however, nothing is more precious to us than our national culture, based on ethical traditions, on a national history and language, in ways of acting and of being which we identify as our own and which give to the human species that variety which enriches us all. I suggest, therefore, that the Conference think not only on the benefits which we may gather by this means, but on the dangers which we all must avoid by agreement among nations.

Finally, I cannot avoid mentioning the concern of my Government about the growing possibility of the use of outer space for warlike purposes. Even today the lower limits of space are the imperative pathway for engines of destruction during their tests. The existence of these instruments of mass destruction sheltered under the earth's surface or hidden in the oceans is, by itself, a terrible and sufficient threat to all of us. I do not believe that the invention of new weapons and their deployment in space will, in any manner, increase the security of any country. It rather appears to me that the multiplication of armaments has to be stopped and nullified in all environments and that this Conference, honouring its name, can contribute to the continuing of outer space as the last region within the reach of man which is totally weapon free.

In the name of the Brazilian Government and people I present compliments to the President of the Conference and to his Bureau. I wish to all participants a harmonious and fruitful labour that may contribute to peace and progress for mankind.

## CHINA

### Mr. Zhao Ziyang, Premier of the State Council

[Original: English]

On the occasion of the convening of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, I wish to extend warm congratulations to the Conference on behalf of the Chinese Government and people.

UNISPACE 82 is an important international conference concerning questions of outer space and has received close attention from various countries in the world. It is our hope that this Conference will make positive contributions to the promotion of outer space science and technology in the service of peaceful purposes, to the enhancement of co-operation based on equality between all the Governments and peoples in the field of outer space science and technology and to the furtherance of the economic development and social progress of all countries, developing countries in particular. May the Conference be successful.

## INDIA

### Mrs. Indira Gandhi, Prime Minister

[Original: English]

The 25 years since man first successfully demonstrated his ability to launch objects into space have seen many notable achievements.

Men and automated spacecraft have landed on the moon. Man-made spacecraft have reached Mars and Venus and explored the outer planets. Through these and other scientific developments, humankind's understanding of the universe, and I hope of itself, has been enriched. Closer to earth, communications satellites, weather satellites and remote sensing satellites are being increasingly used by peoples in their day-to-day activities.

At the same time it is pertinent to ask if such spectacular advances, which in some ways have brought the world together have also contributed to reducing the glaring disparities which divide peoples, the rich and the poor, the haves and the have-nots. The promise of gains from advanced technologies elude the majority of peoples, whose aspirations for a better and richer life remain unfulfilled.

A global conference on space is an opportunity. I urge scientists and world leaders to see the world in its wholeness, as indeed it is viewed from space and, through their collective wisdom, take practical steps to ensure that our differences are not extended into space. Let there be peace in space, so that all humanity can benefit.

On behalf of the Government of India, I send good wishes for a successful conference.

## UNION OF SOVIET SOCIALIST REPUBLICS

### Mr. L. Brezhnev, Chairman of the Presidium of the Supreme Soviet

[Original: Russian]

I should like to greet cordially the participants in the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

Your Conference has been convened on the eve of a momentous date - the twenty-fifth anniversary of the space age, which began with the launching in the Soviet Union on 4 October 1957 of the first artificial earth satellite. This tremendous feat of human genius ranks among the greatest events of world history.

Mankind can be justifiably proud of what has been accomplished over the past 25 years. The conquest of outer space is proceeding with truly cosmic speed: from the first artificial earth satellite and the first orbit around our planet by Yuri Gagarin to the large-scale orbiting complexes and manned space flights lasting several months as well as the long-range expeditions to the moon, Mars and Venus.

Today cosmonautics has also been directly applied to economic tasks of a purely earth-bound nature. It has become the dependable ally of geologists and navigators, agronomists and meteorologists, communications experts and doctors, cartographers and forestry workers.

If one looks into the near future, the question of creating in outer space permanently functioning laboratories on board increasingly large orbiting complexes with rotated crews will be considered. Indeed, the creative potential of man in his daring onslaught of the outer reaches of space is unlimited.

The successful development of international co-operation in the exploration and use of outer space, in which a leading role is played by the United Nations, gives cause for satisfaction. This co-operation is diverse in form and extremely rich in content.

It is particularly gratifying that the first international crews sent into outer space under the INTERCOSMOS programme, which is being carried out by the socialist countries, have already orbited the earth. The citizens of 10 countries together with our cosmonauts have carried out space flights on board Soviet space ships and stations. We are prepared to continue to assist international space flights.

Co-operation in outer space should unite people and promote understanding of the fact that we are all living on the same planet and that a peaceful and prosperous earth depends on us all.

The Soviet Union has consistently maintained that outer space should remain an arena for peaceful co-operation and that the unlimited expanses of outer space should be free from weapons of any type. The achievement of this great and humanitarian goal through joint efforts is both feasible and vitally necessary for the future of all mankind.

I wish the participants in the Conference every success in their work and express the hope that the results of the Conference will serve the cause of strengthening peace, mutual understanding and co-operation and further progress in the conquest of outer space for the good of all the people of our planet.

## PAKISTAN

### Mr. M. Zia ul-Haq, President

[Original: English]

It gives me great pleasure to extend warm greetings to the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 1982).

Barely 25 years ago the human race, for the first time, succeeded in going beyond the confines of the planet earth and entered the new frontier of outer space. Today, our activities in space have begun to exercise a significant and to a large extent beneficial influence on our daily lives in many diverse ways. Artificial satellites are providing an excellent communications service between distant points on the globe and bringing closer to reality the concept of the "global village". Satellites forecast weather with improved accuracy, and record the over-all situation of crops and other vegetation. They help us survey the natural resources of the planet, map the earth, monitor its environment, aid marine, air and ground navigation and perform search and direct rescue missions for people in distress. The list of benefits, already impressive, will include more and more activities as time passes. There is no doubt in my mind that space applications and technology have a great potential in the service of humanity because they help us to plan better and acquire a greater degree of control over our destiny.

Unfortunately, there is another side to the coin. An estimated 75 per cent of the satellites launched since the first Sputnik had military applications. As the international community attempts in other forums to promote the objectives of disarmament, I hope that UNISPACE 82 will do its best to ensure that the promising new frontier of space does not become an arena for military competition and confrontation.

The outer space Treaty, which prohibited the introduction of weapons of mass destruction in orbit around the earth, and reserved celestial bodies exclusively for peaceful purposes, was a good beginning. I hope and pray that the Conference can reaffirm strongly that outer space will be used only for peaceful purposes, and for the benefit of the entire humanity.

The world is already deriving benefits from the technology of space. One of the principal aims of UNISPACE 82 is to consider ways and means of enabling developing countries to benefit from this technology to raise the standards of living of their peoples. I am confident that in spite of difficulties and limitations, which we all recognize, the gathering in Vienna will have the vision to address itself to its historic task. In the noble endeavour of using the technology of space to solve problems of this planet, Pakistan will play its part in promoting space science for the benefit of all the peoples of the world.

I wish the organizers and participants of the world Conference every success.

## BULGARIA

### Mr. Todor Zhivkov, Chairman of the State Council

[Original: Russian]

On behalf of the State Council and the Government of the People's Republic of Bulgaria, and on my own behalf, it is my pleasure to extend greetings to this important meeting, convened in order to discuss the present and future status and utilization of space science and technology, international co-operation and the role of the United Nations in outer space matters.

The exploration and peaceful uses of outer space are among the greatest achievements of the scientific and technological revolution in our twentieth century. They are opening up broad avenues for constructive co-operation between States. We shall all soon be celebrating the twenty-fifth anniversary of the birth of the space age, heralded by the signals of the first artificial satellite of our planet. Since then, the exploration and use of outer space has proved to be of great benefit to people.

Your Conference is especially significant because it is taking place during a period of marked aggravation of the international situation, when the threat of nuclear war hangs over the peoples. Space is the common property of mankind. Peace - the most important prerequisite for mankind's existence - is also common property. For this reason, it is vitally important to avert completely the danger of outer space being transformed into a stage for the arms race, not to place there any weapons whatsoever and not to make outer space a source of additional tension between States. The exploration and use of outer space can and must serve only the peoples' well-being and the goals of development and social progress, and promote the preservation and strengthening of peace throughout the world.

By its participation in the United Nations, the People's Republic of Bulgaria consistently and steadfastly makes its modest contribution to the attainment of these goals.

In addition, the People's Republic of Bulgaria is an active participant in the INTERCOSMOS programme for the exploration and use of outer space. This programme encompasses important scientific and technological research, experiments and joint flights, which are a new and substantial contribution to the practical conquest of space in the interests of all countries.

Allow me to wish the Conference success in its work and to express the conviction that it will permit the development of business-like exploration and peaceful uses of outer space, for the benefit of States and peoples.

## UNITED STATES OF AMERICA

### Mr. Ronald Reagan, President

[Original: English]

This Second United Nations Conference on the Peaceful Uses of Outer Space provides leaders from around the globe with an unprecedented opportunity to chart a course for greater co-operation among nations in exploring mankind's last and endless frontier.

Let us resolve to work together to ensure that the benefits of space continue to contribute to a bright and peaceful future on earth. And let us also chart new pathways to the stars to serve as avenues of peaceful exploration and adventure for our generation and for generations to come.

## Annex II

## LIST OF DOCUMENTS

### A. Basic Conference documentation

| Symbol | Title |
|---|---|
| A.CONF.101/1 | Provisional rules of procedure |
| A/CONF.101/2 | Provisional agenda |
| A/CONF.101/3 and Add.2 | Draft report of the Conference |
| A/CONF.101/3/Add.1 | Draft report of the Conference - Note on financial implications |
| A/CONF.101/4 | Objectives of the Conference as approved by the Preparatory Committee and endorsed by the General Assembly |
| A/CONF.101/5 and Corr.1 | Declaration of the Group of 77 |
| A/CONF.101/6 | Report of the First Committee |
| A/CONF.101/7 | Report of the Credentials Committee |
| A/CONF.101/8 and Corr. 1-4 | Report of the Second Committee |
| A/CONF.101/9 and Corr.1 | Report of the Third Committee |
| A/CONF.101/10 | Report of the Conference |
| A/CONF.101/L.1 | Report of the Pre-Conference Consultations held at the Hofburg Conference Centre, Vienna on 8 August 1982 |
| A/CONF.101/L.2 and Add.1 | Adoption of the Report of the Conference - Draft report of the Conference |
| A/CONF.101/L.3 | Proposal submitted by Mexico on behalf of the Group of 77 |
| A/CONF.101/L.4 | Text resulting from the consultations of the "Friends of the President" |
| A/CONF.101/L.5 | Algeria: Amendment to paragraph 25 of document A/CONF.101/L.2/Add.1 |
| A/CONF.101/C.1/L.1 | Annotated Programme of Work - Committee I |
| A/CONF.101/C.2/L.1 | Annotated Programme of Work - Committee II |
| A/CONF.101/C.3/L.1 | Annotated Programme of Work - Committee III |
| A/CONF.101/C.3/L.2 | Note by the Secretariat |

### Information documents

| | |
|---|---|
| A/CONF.101/INF.1 | Information note on the preparation of national papers |
| A/CONF.101/INF.2 and Corr.1 and 2 | List of participants |
| A/CONF.101/INF.3 | United States initiatives at UNISPACE 82 |
| A/CONF.101/MISC.1 | List of documents |
| A/CONF.101/MISC.2 and Add.1-3 | List of participants |
| A/CONF.101/ORGANIZATION | Organization of the work of the Conference - Note by the Secretariat |

## B. National papers and abstracts

| Country | National papers Symbol | Available Languages | Abstract Symbol | Available Languages |
|---|---|---|---|---|
| ARGENTINA | A/CONF.101/NP/22 | (S) | A/CONF.101/AB/22 | (A,C,E,F,R,S) |
| AUSTRALIA | A/CONF.101/NP/46 | (E) | A/CONF.101/AB/46 | (A,C,E,F,R,S) |
| AUSTRIA | A/CONF.101/NP/44 | (E) | A/CONF.101/AB/44 | (A,C,E,F,R,S) |
| BANGLADESH | A/CONF.101/NP/7 | (E) | A/CONF.101/AB/7 | (A,C,E,F,R,S) |
| BOLIVIA | A/CONF.101/NP/54 | (S) | A/CONF.101/AB/54 | (A,C,E,F,R,S) |
| BRAZIL | A/CONF.101/NP/43 | (E) | A/CONF.101/AB/43 | (A,C,E,F,R,S) |
| BULGARIA | A/CONF.101/NP/27 | (E) | A/CONF.101/AB/27 | (A,C,E,F,R,S) |
| BULGARIA/CUBA | A/CONF.101/NP/50 | (S,E) | A/CONF.101/AB/50 | (A,C,E,F,R,S) |
| CANADA | A/CONF.101/NP/29 | (E) | A/CONF.101/AB/29 | (A,C,E,F,R,S) |
| CHILE | A/CONF.101/NP/18 | (S) | A/CONF.101/AB/18 | (A,C,E,F,R,S) |
| CHINA | A/CONF.101/NP/13 | (C,E) | A/CONF.101/AB/13 | (A,C,E,F,R,S) |
| COLOMBIA | A/CONF.101/NP/42 and Add.1 | (S) | A/CONF.101/AB/42 | (A,C,E,F,R,S) |
| CUBA | A/CONF.101/NP/20 | (S) | A/CONF.101/AB/20 | (A,C,E,F,R,S) |
| CZECHOSLOVAKIA | A/CONF.101/NP/8 | (E) | A/CONF.101/AB/8 | (A,C,E,F,R,S) |
| ECUADOR | A/CONF.101/NP/19 | (S) | A/CONF.101/AB/18 | (A,C,E,F,R,S) |
| EGYPT | A/CONF.101/NP/1 | (E) | A/CONF.101/AB/1 | (A,C,E,F,R,S) |
| EUROPEAN SPACE AGENCY | A/CONF.101/NP/37 | (E,F) | A/CONF.101/AB/37 | (C,E,F,R,S) |
| (ESA: Belgium, Denmark, France, Germany, Federal Republic of, Ireland, Italy, Netherlands, Spain, Switzerland, United Kingdom of Great Britain and Northern Ireland) | | | | |
| FINLAND | A/CONF.101/NP/33 | (E) | A/CONF.101/AB/33 | (A,C,E,F,R,S) |
| GERMAN DEMOCRATIC REPUBLIC | A/CONF.101/NP/16 | (E) | A/CONF.101/AB/16 | (A,C,E,F,R,S) |
| GREECE | A/CONF.101/NP/36 | (E) | A/CONF.101/AB/36 | (A,C,E,F,R,S) |
| HUNGARY | A/CONF.101/NP/45 | (E) | A/CONF.101/AB/45 | (A,C,E,F,R,S) |
| INDIA | A/CONF.101/NP/6 | (E) | A/CONF.101/AB/6 | (A,C,E,F,R,S) |
| INDONESIA | A/CONF.101/NP/11 | (E) | A/CONF.101/AB/11 | (A,C,E,F,R,S) |
| ISRAEL | A/CONF.101/NP/56 | (E) | A/CONF.101/AB/56 | (A,C,E,F,R,S) |
| JAPAN | A/CONF.101/NP/39 | (E) | A/CONF.101/AB/39 | (A,C,E,F,R,S) |
| JORDAN | A/CONF.101/NP/40 | (E) | A/CONF.101/AB/40 | (A,C,E,F,R,S) |
| KENYA | A/CONF.101/NP/12 | (E) | A/CONF.101/AB/12 | (A,C,E,F,R,S) |
| MALAWI | A/CONF.101/NP/34 | (E) | A/CONF.101/AB/34 | (A,C,E,F,R,S) |

| | | | | |
|---|---|---|---|---|
| MALAYSIA | A/CONF.101/NP/58 | (E) | A/CONF.101/AB/58 | (A,C,E,F,R,S) |
| MONGOLIA | A/CONF.101/NP/28 | (R) | A/CONF.101/AB/28 | (A,C,E,F,R,S) |
| MONGOLIA/USSR | A/CONF.101/NP/32 | (E) | A/CONF.101/AB/32 | (A,C,E,F,R,S) |
| MOROCCO | A/CONF.101/NP/23 | (F) | A/CONF.101/AB/23 | (A,C,E,F,R,S) |
| NETHERLANDS | A/CONF.101/NP/17 and Corr.1 | (E) | A/CONF.101/AB/17 | (A,C,E,F,R,S) |
| NEW ZEALAND | A/CONF.101/NP/26 | (E) | A/CONF.101/AB/26 | (A,C,E,F,R,S) |
| NIGERIA | A/CONF.101/NP/35 | (E) | A/CONF.101/AB/35 | (A,C,E,F,R,S) |
| NORWAY | A/CONF.101/NP/47 and Add.1 | (E) | A/CONF.101/AB/47 | (A,C,E,F,R,S) |
| OMAN | A/CONF.101/NP/38 | (E) | A/CONF.101/AB/38 | (A,C,E,F,R,S) |
| PAKISTAN | A/CONF.101/NP/21 | (E) | A/CONF.101/AB/21 | (A,C,E,F,R,S) |
| PERU | A/CONF.101/NP/15 | (S) | A/CONF.101/AB/15 | (A,C,E,F,R,S) |
| PHILIPPINES | A/CONF.101/NP/3 | (E) | A/CONF.101/AB/3 | (A,C,E,F,R,S) |
| POLAND | A/CONF.101/NP/31 | (E) | A/CONF.101/AB/31 | (A,C,E,F,R,S) |
| PORTUGAL | A/CONF.101/NP/55 | (E) | A/CONF.101/AB/55 | (A,C,E,F,R,S) |
| ROMANIA | A/CONF.101/NP/24 | (F) | A/CONF.101/AB/24 | (A,C,E,F,R,S) |
| SAUDIA ARABIA | A/CONF.101/NP/52 | (E,A) | A/CONF.101/AB/52 | (A,C,E,F,R,S) |
| SENEGAL | A/CONF.101/NP/57 | (F) | A/CONF.101/AB/57 | (A,C,E,F,R,S) |
| SRI LANKA | A/CONF.101/NP/10 | (E) | A/CONF.101/AB/10 | (A,C,E,F,R,S) |
| SUDAN | A/CONF.101/NP/51 | (E) | A/CONF.101/AB/51 | (A,C,E,F,R,S) |
| SWEDEN | A/CONF.101/NP/9 and Add.1 | (E) | A/CONF.101/AB/9 | (A,C,E,F,R,S) |
| SYRIAN ARAB REPUBLIC | A/CONF.101/NP/2 | (E) | A/CONF.101/AB/2 | (A,C,E,F,R,S) |
| THAILAND | A/CONF.101/NP/5 | (E) | A/CONF.101/AB/5 | (A,C,E,F,R,S) |
| UGANDA | A/CONF.101/NP/48 | (E) | A/CONF.101/AB/48 | (A,C,E,F,R,S) |
| UNION OF SOVIET SOCIALIST REPUBLICS | A/CONF.101/NP/30 and Corr.1 | (E) | A/CONF.101/AB/30 | (A,C,E,F,R,S) |
| UNITED STATES | A/CONF.101/NP/53 | (E) | A/CONF.101/AB/53 | (A,C,E,F,R,S) |
| UPPER VOLTA | A/CONF.101/NP/4 | (F) | A/CONF.101/AB/4 | (A,C,E,F,R,S) |
| URUGUAY | A/CONF.101/NP/41 | (S) | A/CONF.101/AB/41 | (A,C,E,F,R,S) |
| VENEZUELA | A/CONF.101/NP/25 | (S) | A/CONF.101/AB/25 | (A,C,E,F,R,S) |
| VIET NAM | A/CONF.101/NP/14 | (E) | A/CONF.101/AB/14 | (A,C,E,F,R,S) |
| YUGOSLAVIA | A/CONF.101/NP/49 | (E) | A/CONF.101/AB/49 | (A,C,E,F,R,S) |

## C. Background papers

| Symbol | Title |
|---|---|
| A/CONF.101/BP/1 and Corr.1<br>Add.1 | Current and future state of space science |
| A/CONF.101/BP/2 | Current and future state of space technology |
| A/CONF.101/BP/3 | Relevance of space activities to monitoring of earth resources and the environment |
| A/CONF.101/BP/4 | Impact of space activities on the earth and space environment |
| A/CONF.101/BP/5 and Corr.1 | Compatibility and complementarity of satellite systems |
| A/CONF.101/BP/6 | Feasibility and planning of instructional satellite systems |
| A/CONF.101/BP/7 | Efficient use of the geostationary orbit |
| A/CONF.101/BP/8 | Relevance of space activities to economic and social development |
| A/CONF.101/BP/9 | Training and education of users of space technology |
| A/CONF.101/BP/10 | Multilateral intergovernmental co-operation in space activities |
| A/CONF.101/BP/11 and Add.1<br>Add.1/Corr.1<br>Add.2 | Role of the United Nations system in space activities |
| A/CONF.101/BP/12 | Role of non-governmental organizations in space activities |
| A/CONF.101/BP/13 | Summary of recommendations made by the regional and interregional seminars of the United Nations Space Applications Programme in connexion with the Conference |
| A/CONF.101/BP/14 | Background paper: Report on UNISPACE Forum |

## D. Papers submitted by intergovernmental organizations

| Symbol | Organization and title |
|---|---|
| A/CONF.101/BP/IGO/1 | Report on the civil aviation interests in the use of outer space. International Civil Aviation Organization (ICAO) |
| A/CONF.101/BP/IGO/2 | Background paper. International Maritime Satellite Organization (INMARSAT) |
| A/CONF.101/BP/IGO/3 | Role of IMCO in the development of space technology for maritime purposes. Inter-Governmental Maritime Consultative Organization (IMCO) |

| | |
|---|---|
| A/CONF.101/BP/IGO/4 | Background paper. Arab Satellite Communications Organization (ARABSAT) |
| A/CONF.101/BP/IGO/5 | Background paper. United Nations Office of the Disaster Relief Coordinator (UNDRO) |
| A/CONF.101/NP/IGO/6 | Report on remote sensing applied to renewable resources. Food and Agriculture Organization of the United Nations (FAO) |
| A/CONF.101/BP/IGO/7 | Report of the meeting of the Group of Experts on Satellite Remote Sensing for Natural Resources. Department of Technical Co-operation for Development (DTCD) |
| A/CONF.101/BP/IGO/8 and Corr.1 | Satellites in meteorology, oceanography and hydrology. World Meteorological Organization (WMO) |
| A/CONF.101/BP/IGO/9 | Contribution of the International Radio Consultative Committee to UNISPACE 82. International Telecommunication Union (ITU) |
| A/CONF.101/BP/IGO/10 | Background paper. Committee on Science and Technology |
| A/CONF.101/BP/IGO/11 (E,F) | Background paper. The European Community (EC) |
| A/CONF.101/BP/IGO/12 (E,F,R,S) | Satellite systems in support of WMO programmes and joint programmes with other international organizations. World Meteorological Organization (WMO) |
| A/CONF.101/BP/IGO/13 | Background paper. Potential applications of space-related technologies to developing countries (UNIDO) |
| A/CONF.101/BP/IGO/14 and Corr.1(F) | Background paper. International Radio Consultative Committee (CCIR) - International Telecommunication Union |
| A/CONF.101/BP/IGO/15 | Background paper. International Telecommunication Union. Application of space telecommunications for development service prospects for the rural areas. |
| A/CONF.101/BP/IGO/16 | Background paper. International Telecommunication Union. List of CCIR recommendations and reports of interest to UNISPACE II |

## E. Papers submitted by non-governmental organizations

| | |
|---|---|
| A/CONF.101/BP/NGO/1 (E) | Outer space and world order. International Peace Research Association (IPRA) |
| A/CONF.101/BP/NGO/2 (E) | An international space programme. International Association of Educators for World Peace (IAEWP) |
| A/CONF.101/BP/NGO/3 (E) | Background paper. Check List - Disaster Warning and Prevention, Emergency Medical Care, Emergency Communications - Prepared by the Sub-Committee on Worldwide Disaster Response, Rescue and Safety of the International Academy of Astronautics |

| | |
|---|---|
| A/CONF.101/BP/NGO/4 (E) | Background paper. Proposition on the Preservation of Peace in Space - Submitted by International Association of Educators for World Peace |
| A/CONF.101/BP/NGO/5 | Background paper. Energy from space for use on earth - Submitted by International Solar Energy Society |
| A/CONF.101/BP/NGO/6 | Background paper submitted by Bahá'í International Community |
| A/CONF.101/BP/NGO/7 | Background paper submitted by International Federation for Home Economics |
| A/CONF.101/BP/NGO/8 | Background paper submitted by the World Association of Former United Nations Internes and Fellows |
| A/CONF.101/BP/NGO/9 | Background paper. Energy from biomass. Submitted by the Society for International Development |

## F. Documents issued before the Conference

1. Report of the Committee on the Peaceful Uses of Outer Space. General Assembly Official Records: 34th Session; Supplement No. 20 (A/34/20)

2. Report of the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. General Assembly Official Records: 35th Session; Supplement No. 46 (A/35/46)

   Report of the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. General Assembly Official Records: 36th Session; Supplement No. 46 (A/36/46)

   Report of the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. General Assembly Official Records: 37th Session; Supplement No. 46 (A/37/46)

3. Reports of the Advisory Committee

| | |
|---|---|
| A/CONF.101/PC/1 | Report of the Advisory Committee to the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space |
| A/CONF.101/PC/4 and Corr.1 | Report of the Second Session of the Advisory Committee to the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space |
| A/CONF.101/PC/6 | Report of the Advisory Committee to the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space on its third session |

## G. Documents of the Pre-Conference Consultation

| | |
|---|---|
| A/CONF.101/PRE-CONF/L.1 and Add.1 | Annotated list of questions |
| A/CONF.101/PRE-CONF/L.2 | Proposed schedule (time table) for the work of the Conference |

# REPORT
# OF THE
# SECOND UNITED NATIONS CONFERENCE
# ON
# THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE-82)

VIENNA, AUSTRIA

AUGUST 9-21, 1982

Submitted to the Secretary of State:

James M Beggs

Ambassador James M. Beggs
Chairman of the Delegation

September 30, 1982
Date

Prepared by the Office of the
U.S. Coordinator for UNISPACE-82
Department of State:

Gerald B. H

Ambassador Gerald B. Helman

# REPORT OF THE
# SECOND UNITED NATIONS CONFERENCE
# ON
# THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE-82)

Vienna, Austria
August 9-21, 1982

## I. SUMMARY

The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE-82) took place in Vienna from August 9-21, 1982. Ninety-four countries participated and developed an extensive report on the present and prospective applications of outer space technology. Particular emphasis was given in that report to the application of that technology for the benefit of developing countries.

The U.S. participated fully in the conference and was represented by a distinguished delegation led by Ambassador James M. Beggs, Administrator of the National Aeronautics and Space Administration. Through its participation, the U.S. demonstrated its continuing preeminence in space applications and the important role of the private sector in the development and application fo space technology. The U.S. suggested specific actions which may be taken to further improve international cooperation in the field of outer space. Through expanded bilateral contacts which the conference facilitated, through the medium of the U.S. exhibit, technical demonstrations, and theater presentations, the U.S. was able to illustrate its contribution to the peaceful uses of outer space and to educate the public and conference delegates on the future benefits to be derived from space applications.

The major political issues discussed at the Conference included the following: regulation of the geostationary orbit and radio frequency spectrum; dissemination and continuity of remote sensing data; direct broadcast television satellites and prior consent; technology transfer and the militarization of space. After extensive debate on those issues, the U.S. was able to negotiate language in the conference report which was compatible with U.S. interests in space.

Looking to the future, the conference report suggests a variety of ways in which international cooperation can be expanded. It will be up to the Outer Space Committee and other multilateral institutions to undertake the many recommendations contained in the report. The U.S. will be expected to implement the eight undertakings it announced during the course of UNISPACE-82.

## II. SCOPE AND PURPOSE OF THE CONFERENCE

The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE-82) was held in Vienna, Austria, August 9-21, 1982. The first such conference took place in Vienna in 1968. In the intervening time, there has been great progress in man's ability to operate in space and in the real and potential benefits that space technologies bring to the development process. Since 1968, man has walked on the moon, landed probes on Mars and Venus and investigated in considerable detail Jupiter and Saturn. About 140 countries use satellite communications systems and more than 100 countries are believed to have used data from the U.S. LANDSAT remote sensing satellites. The U.S. Space Shuttle has introduced a new age of space activity.

At the same time, increased activity in space and advances in space technology have raised a number of issues with respect to how this technology can most effectively be employed by user nations and aid in development. Developing countries are showing increasing interest in expanding their space and space applications programs. Several are now embarking on space programs of their own; their number will increase.

As a consequence of these development, the United Nations General Assembly, by Resolution 33/16 of November 10, 1978 decided to convene UNISPACE-82. A subsequent resolution, 34/67 of December 5, 1979 authorized the convening of the conference and set forth general objectives (see Annex IV).

## III. ORGANIZATION OF UNISPACE-82

Planning and preparatory work for the conference thereafter took place under the auspices of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). Substantive preparations for the conference proceeded through the submission of national papers by 54 UN members. The U.S. National Paper was submitted on March 23, 1982, and is attached as an annex to this report. The various national papers were reviewed by an international secretariat, whose Secretary General was Prof. Yash Pal of India. The Secretariat issued a draft report to serve as the basis for discussions on a final report of UNISPACE. The draft was reviewed by the COPOUS which, at its meeting in New York during March/April 1982, reached agreement on all but 15 of 430 paragraphs. The report, the main headings of which correspond to the subjects which the General Assembly mandated to the UNISPACE Conference, was also the principle focus for discussions in the Main Committees of the Conference.

UNISPACE-82 operated through plenary and committee sessions. The plenary was devoted to hearing national statements by participating countries, some delivered by heads of state via live satellite transmission, and to considering and approving the final report of the conference to the General Assembly. The report, the text of which is contained at Annex 3, will be considered by the General Assembly at its 37th session.

The Conference President was the Foreign Minister of Austria, Willibald Pahr. The conference had seventeen vice-presidents, a Rapparteur-General and chairmen for each of the three main committees. These positions were allocated on the basis of equitable geographic distribution.

## IV. ISSUES

The main issues before UNISPACE were defined at some length in the agenda, and were allocated for discussion in each committee as follows:

-- Committee I, state of space science and technology:

(a) review and projection of the current and future state of science and technology for space research and applications;

(b) evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far.

-- Committee II, application of space science and technology, including:

(a) evaluation of the current and potential applications of space technology, taking into account present and foreseeable national and international programs in the areas of space research;

(b) examination of the possibilities and mechanisms for enabling all States to benefit from space technology, bearing in mind their various levels of development, varying capacities to absorb new technologies and particular needs and priorities;

(c) examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard;

(d) examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measures to augment their capabilities to develop space technology and facilitate access to such technology and to participate and cooperate in space activities so as to derive maximum benefit from space technology and its applications;

(e) examination of development and system configurations appropriate to the use of space technology for education;

(f) discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation;

(g) consideration of the implications of projected developments in the areas of space technology such as earth-orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end;

(h) discussion of the nature of, and ways of protecting the near-earth environment, including the upper atmosphere and magnetosphere.

-- Committee III, International Cooperation and the role of the United Nations, including:

(a) consideration of reports on the nature and extent of the bilateral and multilateral cooperation in outer space activities;

(b) consideration of reports on the activities of the United Nations, including its specialized agencies, and of other international organizations dealing with the exploration and peaceful uses of outer space;

(c) evaluation of the role of the United Nations, its specialized agencies, other international organizations and programs of bilateral and multilateral cooperation in order to ensure broad international cooperation on an equal basis;

(d) evaluation of the role of the United Nations in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role.

The discussions at UNISPACE, and the Report of the Conference, largely followed the agenda, several issues were given particular attention:

(A) The geostationary Orbit. Developing countries have been concerned that present patterns of use of the GSO are inequitable and that GSO positions will not be available for their use in the future because of the preemption by satellites of countries and international organizations with existing space programs, primarily the U.S. and USSR. This view has given impetus to demands that developing country interests be specially provided for, such as by changes in the regulating mechanism for access to the GSO. Some Equatorial Countries have claimed sovereignty over parts of the GSO. The U.S., together with the other developed countries, including the USSR, has supported equitable access by all to the GSO and rejected claims of sovereignty. Few developing countries accepted such claims.

(B) Radio Frequency Allocation. Developing countries have, similarly, been concerned about the continuing availability of the radio frequency spectrum for their space communications needs. This concern has led some countries to suggest that allocations at 4 and 6 GHZ be reserved exclusively for developing country use or that power flux density limitations within these bands be relaxed or eliminated. The U.S. has been unwilling to accept either discriminatory application of the International Telecommunications Union (ITU) regulations or additional interference in satisfying national terrestrial traffic requirements. Relaxing power flux density requirements would create interference to existing terrestrial systems and equipment.

(C) Dissemination and Continuity of Satellite Remote Sensing Data. Some countries have become concerned over the unrestricted dissemination of satellite remotely sensed data. In addition, some are calling for guarantee of continued service in this area. Some countries would like guaranteed or priority access to data about their territory. The U.S. supports the open acquisition and public non-discriminatory dissemination of data from civil remote sensing systems. We recognize concerns about data continuity at reasonable cost, and system compatibility and complementarity.

(d) Direct (television) Broadcast Satellites and Prior Consent. There has been long standing concern over direct television broadcasting from satellites. A large number of governments have apprehensions about other countries or entities using satellites to broadcast television signals directly to their populations without consent of the receiving government. Some countries assert a right to control of such direct TV broadcasts. The U.S. has supported free flow of information and opposed establishing any direct broadcast principles restricting free flow by establishing rules on program content or prior political consent to direct broadcasting.

(E) Technology Transfer. Developing countries generally have pressed for an accelerated flow of technology from developed countries. In UNISPACE, developing countries urged that they be assisted in infrastructure development and in establishing a capability to produce their own space-related hardware. The U.S. has supported improving the ability of developing countries to generate and effectively apply space as well as other technologies, but technology transfer should occur on a mutually beneficial basis consistent with property rights and sound administrative and economic practices.

(F) Militarization. The major contentious issue at UNISPACE-82, although it was not on the agenda, related to concerns with the "militarization" of space. Many countries felt that such a development was occurring and was incompatible with the use of space for peaceful purposes. Some suggested banning all military activities in space, while others were concerned about the introduction of weapons systems into space. The U.S. resisted any discussion of substantive arms control questions at UNISPACE-82. We supported limiting the use of outer space to peaceful purposes, including non-aggressive military activities, but suggested that the proper place for consideration of arms control-related issues is the Committee on Disarmament.

## V. U.S. PURPOSE AND OBJECTIVES

The United States participated in UNISPACE-82 through its delegation and through a related exhibit and space technology demonstrations. Our overall effort was designed to express our continued preeminence in space and our intention to maintain leadership in broad, mutually beneficial cooperative programs of space science and technology applications. Specifically, we sought to direct attention to ways in which space applications can work for development.

Additionally, through our delegation, which included distinguished private, as well as public sector representatives and through our exhibit and presentations, we clearly showed that U.S. achievements are the result of the close and productive collaboration between the government and the private sector.

In elaborating our purpose at UNISPACE-82, the U.S. specifically sought to:

- -- describe its present achievements and future objectives in outer space;
- -- elaborate on its ideas for specific programs of international cooperation involving the public and private sector;
- -- work for the establishment of sensible priorities among proposals made;
- -- encourage attention to the wider educational possibilities the conference offers; and
- -- demonstrate its space applications which assist economic development in the third world.

## VI. U.S. PREPARATIONS

### A. General Organization

With these objectives in mind, a Coordinator's office was established in the Department of State in February 1982 under Ambassador Gerald B. Helman and a small staff. In the prior month, an interagency group had met to help lay the groundwork for the establishment of the U.S. Coordinator's office. This office worked in close cooperation with NASA Administrator James M. Beggs, who was named Head of Delegation by President Reagan in April, 1982. The first task was the convening of an inter-agency coordinating committee under Ambassador Helman made up of representatives of all concerned agencies (State, NASA, Commerce (NOAA, NTIA), FCC, AID, USGS, NSC, DOD, CIA, USDA, OSTP). The preparatory work was divided into specific areas and tasks. These involved the development of position and issue papers, background papers, initiatives, a public affairs strategy, technical demonstrations, the U.S. Exhibit and the "U.S. Night Presentation." Briefings were held for private sector representatives, non-governmental organizations, and other interested groups. Congress was regularly briefed and consulted.

Internationally, intensive negotiations took place in the UN Committee on the Peaceful Uses of Outer Space (UN/COPUOS) and its Scientific and Technical Subcommittee meetings in January, March and April 1982, on the content of the draft UNISPACE Report. The conference also allowed extensive consultations with other governments, including our allies, on UNISPACE and our approach to the issues involved. In addition, Asian, Latin American and African regional meetings were held under the sponsorship of the UN to which the U.S. sent representatives to both explain the U.S. viewpoint and to better understand the views of countries within each region.

The Department of State sent out (in April) a circular telegram to all posts providing them with early guidance and information on the U.S. positions at the conference and asking for views of host governments. Subsequent instructions covered special issues which posts were asked to take up with host governments.

While the U.S. was late in deciding to participate in the conference due to a conflict over a UN personnel appointment, once the decision was made and the Coordinator's office established, through the interagency group a strategy was rapidly developed to accomplish our basic objectives of demonstrating our continued leadership in space, our open approach to international cooperation, and the relevance of our space program to the development process.

### B. U.S. Exhibit

To demonstrate our leadership effectively, a well-known professional designer and display director (Robert Jani of Los Angeles) was enlisted and placed under contract by NASA to organize the associated U.S. exhibit that was to be held at the Messepalast in Vienna during the conference. Vice President Bush lent his prestige to enlist the participation in the exhibit by U.S. aerospace companies. Some 170,000 people eventually saw the U.S. exhibit, which was universally gauged as successful. Through close work and coordination between industry and the United States, the exhibit served to demonstrate not only our leadership but the benefits of our space technologies to other countries. It also underscored the critical role of the private sector in space technology applications. The American Institute of Aeronautics and Astronautics also assisted in coordinating the Exhibit plans with industry. An element of success of the Exhibit was the use of USG college-age dependents abroad as guides to assist in the interpretation of the exhibits, and otherwise assist the visitors.

C. Demonstrations

In the same way, demonstrations of U.S. space technology were developed for display at the main conference site in Vienna. These demonstrations, with assistance of the private sector, included the AID Rural Satellite program, microprocessing, LANDSAT data, and applications of photovoltaic powered equipment. Some demonstrations utilized satellite links between Vienna and the U.S. discussing development applications. COMSAT established a satellite line between UN Headquarters in New York City and the conference which was used for remote interpretation and traslation services. Further, the U.S. sponsored a series of technical lectures on our space activities and several of our initiatives.

D. Initiatives

Of great importance to our overall strategy were specific initiatives which we developed to demonstrate the importance we attach to relating space technology to economic development. These initiatives served as a contrast to many other advanced countries, especially the Soviet Union, which offered nothing comparable. The main U.S. initiatives included:

-- A Global Habitability Study - an international cooperative research effort to obtain information, including through space-based systems, on changes of natural and human origin affecting the habitability of the earth;

-- A Communications Satellite Technology Seminar - to be held for developing country experts in 1983 in cooperation with Hughes Aircraft in association with the Institute for Telecommunications Training and World Communications Year.

-- A feasibility study of the development of an international emergency disaster assistance communications system;

-- A conference on the Application of Space Technologies for Disaster Monitoring and Early Warning, sponsored by AID, to be held in Washington in 1984;

-- Promoting access by developing countries to new remote sensing microprocessors by providing regional training; we also provided to all countries at the conference a special LANDSAT index showing the availability of images for over a decade of the program;

-- An annual meeting of space technology experts sponsored jointly by Columbia University and NASA:

-- A conference to share the results of the U.S. AID's Rural Satellite Program and development of a model low-cost photovoltaic-powered ground station; and

-- A statement supporting removal of government satellites from Geostationary Orbit to help avoid possible crowding of the GSO.

## E. Public Affairs Strategy

A Public affairs strategy was developed in close cooperation with USIA. Its Director, Charles Z. Wick, gave his personal attention to the effort and served as an alternate U.S. representative to the conference. We established an interagency working group and formulated plans for press conferences, wireless file "backgrounders" giving the U.S approach to international space issues, and special publications on U.S. space efforts for worldwide distribution. We also organized a special "U.S. Night" program for delegates, press and VIPs in Vienna. James Michener was host, three American astronauts participated and a filmed statement by President Reagan was shown. Appropriate stories were carried by USICA and VOA reporters, as well as the international press.

## F. U.S. Delegation Organization

The U.S. delegation was diverse, distinguished and very able, (delegation list is at Annex I ). It included leaders in the aerospace industry, lawyers, scientists, Congressional advisors and their staffs, as well as senior officials from interested executive branch agencies. Each was given a role at the conference. As a result, we made early and effective contact with a large number of foreign delegates and fielded highly expert delegations in each of the three main committees. Several members of the delegation also undertook to brief and assist U.S. businessmen interested in the work of the conference and its participants.

## VII. RESULTS OF THE CONFERENCE

UNISPACE-82 considered and approved a report to the General Assembly dealing in considerable detail with the purpose and theme of the conference. It contains several dozen recommendations for future international cooperation on every apsect of international space cooperation. Its analysis of present and prospective applications of space technology is unusually comprehensive.

The report calls attention to the benefit application of space technology can have in developed and developing countries alike. It also notes the advantage developed countries have in exploiting this technology and calls upon them to cooperate in promoting the wider exploitation and beneficial use of space technology in developing countries. International cooperation is recognized as an important factor in assisting countries in this endeavor. At the same time, the report recognizes that each country's ability to make effective use of space technology rests with itself.

The conference dealt responsibly with the issues before it; many of them complex and controversial. Through effective negotiations, and the consensus process, all of these issues were from the U.S. point of view, resolved in a satisfactory manner. While the conference recommendations are not perfect, they are serviceable and if effectively implemented can promote the efficient use of space technology to aid development in all countries.

From the perspective of the United States, UNISPACE-82 was a success:

-- It provided us with an opportunity to demonstrate our preeminence in space technology and applications;

-- We were able to relate that preeminence to the needs of developing countries;

-- The private sector's role was prominent, and its promise of future participation in the development of space technology was made abundantly clear;

-- We are able to develop our views on some of the more controversial outer space issues, and to gain a fuller understanding of contending positions. In no case were any decisions taken which compromise our interests.

## VIII. CONFERENCE FOLLOW UP

The UNISPACE-82 report will be submitted to the General Assembly during its session in the Fall of 1982. We do not expect any controversy over the approval of the report, although it may be the occasion for a review of some of the more contentious issues discussed during the course of the conference. In particular, a number of countries are certain to take the opportunity to renew their expressions of concern regarding the "militarization" of outer space and to suggest ways in which the UN might give that subject priority attention. Discussion by the General Assembly of issues involving the Geostationary Orbit and frequency allocations are likely to be influenced by the result of the ITU Plenipotentary which takes place in Nairobi for six weeks beginning September 28. There may be a discussion of a number of other issues left open by the report, such as the method of pursuing its recommended studies and, in particular, of changing the current UN Secretariat UN Outer Space Division into a more autonomous center.

Over the next few years, the UNISPACE report will serve as a fundamental resource document on the prospects for space technology application and on recommendations for expanding international cooperation. The report contains dozens of recommendations on each aspect of space applications and the Outer Space Committee and subcommittees can be expected to assess which ones merit priority attention. For our part, we should ourselves decide on those which we can support, both through expert participation and funding. Few, if any, of the recommendations can be implemented in the absence of changed budget funding priorities or voluntary contributions by interested states.

We should also take early steps to implement the various initiatives we suggested to the conference. All of them were well received and, with one exception, each are to be implemented through unilateral action on the part of the U.S. The initiatives themselves and their realization will continue to demonstrate both our preeminence in outer space technology and our continuing desire to assist developing countries in availing themselves of that technology.

Attachments:

Annex I - U.S. Delegation List

Annex II - List of Countries Participating in UNISPACE Conference

Annex III - National Paper

Annex IV - Conference Report

(These Annexes are reprinted elsewhere in this volume, see Contents.)

# UNISPACE'82: THE SECOND U.N. CONFERENCE ON OUTER SPACE

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## ISSUE DEFINITION

The United States will participate in the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE'82) from August 9-21, 1982 in Vienna. As a result of a dispute at the United Nations over personnel matters, the United States did not decide to attend the Conference until December 1981. This gives the United States only seven months to prepare for an event for which all other participants have had over two years to prepare. The United States sees UNISPACE'82 as a purely technical conference; however, developing countries are expected to raise political and legal issues as well.

The composition of the U.S. delegation to UNISPACE'82, when the delegation will be named, and whether the delegates will be prepared to discuss political as well a technical issues at the conference are questions of immediate congressional concern. The House Committee on Science and Technology is tentatively planning hearings on UNISPACE'82 for July 14, 1982.

## BACKGROUND AND POLICY ANALYSIS

### 1968 Outer Space Conference

The first United Nations Conference on the Exploration and Peaceful Uses of Outer Space was held in 1968 in Vienna, Austria. Seventy-eight countries and thirteen international organizations took part in the event -- the first international conference devoted to the practical applications of space technology. Dr. Kurt Waldheim, at that time Chairman of the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS), served as Secretary-General of the conference.

The two main objectives of the conference were (1) to examine the practical benefits to be derived from space research and exploration based on achievements in this area and the extent to which non-space powers (particularly developing countries) might enjoy those benefits in terms of education and development; and (2) to examine the opportunities available to non-space powers for international cooperation in space activities, including the role of the United Nations in these matters.

At the conference, the Soviets unveiled plans for Intersputnik, their global communications satellite system. Technical details of the Intersputnik system were not discussed at Vienna, although Soviet delegates did say they planned to expand the Soviet Molniya system into a global network.

The United States saw the Intersputnik proposal as a communist-bloc answer to the then 62-nation International Telecommunications Satellite consortium (INTELSAT) which handled more than 95% of the world's telecommunications traffic at that time. The State Department felt another global system was unnecessary. (To date, there are only 14 members of Intersputnik, all friends of the Soviet Union, while INTELSAT has 106 member nations.)

The conference generated two proposals that later were submitted to COPUOS by India and Sierra Leone. These culminated in (1) the creation of a United Nations Space Applications Program, which provides technical assistance to developing nations through workshops, seminars, and training, and (2) the establishment of working groups in COPUOS to study questions concerning remote sensing, broadcasting satellites, and other space matters of international importance.

## Preparations for a Second Conference

Since the 1968 Conference, the world has witnessed rapid growth in the exploration of space and in space technology. In 1978, COPUOS decided a second space conference (UNISPACE'82) was necessary and would be welcomed especially by developing nations, many of which have an interest in sharing in the benefits offered by participation in outer space activities. In 1980, the U.N. General Assembly scheduled the conference for Aug. 9-21, 1982, in Vienna.

In 1981, the United States decided not to participate in some of the UNISPACE'82 preparations because of a disagreement at the United Nations over who would be named director of the Outer Space Affairs Division, which services COPUOS. It had been anticipated that this director would also serve as executive secretary of the UNISPACE conference. The director of the division, a Czechoslovakian, retired and the United States expected that his deputy, an American, would be named to succeed him; the Soviet Union insisted that another Czech be made head of the division. During 1981, the U.S. attended the COPUOS preparatory meetings for UNISPACE'82, but did not take part in any other preparatory activities such as submitting a national paper or naming a Deputy Secretary-General. A settlement was not reached until the end of December 1981 whereby the American will formally be named director at the UNISPACE meeting (he is acting director until that time) and the Czech candidate will be his deputy and ascend to the position of director when the American retires in May 1983.

An Indian, Yash Pal, is Secretary-General for UNISPACE'82, and a Sri Lankan, Nandasiri Jasentuliyana, is serving as executive secretary. Jerry Grey, administrator for public policy for the American Institute of Aeronautics and Astronautics, has been appointed as one of three deputy secretaries-general for the conference. The other two are Hubert Bortzmeyer (France) and Alla Massevitch (Soviet Union).

## CURRENT STATUS OF PREPARATIONS

## Agenda for UNISPACE'82

All 157 members of the United Nations are among those invited to participate in UNISPACE'82. Delegates from 140 nations are expected to be in attendance in Vienna.

The agenda for UNISPACE'82 will cover three general areas: 1) the state of space science and technology, 2) applications of space science and technology, and 3) international cooperation and the role of the United Nations. The mandate for the Conference is to stimulate the growth of space activities and demonstrate the relationship between space activities and the socio-economic advancement of the world, particularly the less developed countries.

Two conferences of non-governmental organizations (NGOs) also will be held in Vienna in August. First, two NGOs (the Committee on Space Research and the International Astronautical Federation) will co-sponsor a symposium from August 4-6 for space scientists and engineers to discuss the concepts contained in the UNISPACE'82 background papers. It is hoped that the results of the forum will provide an up-to-date technical background for the participants at UNISPACE'82. Second, a conference sponsored by the NGOs affiliated with the United Nations Economic and Social Council is being organized by a planning committee headed by Dr. David Webb. This NGO conference will run parallel with the governmental UNISPACE'82 conference, and many of the political issues associated with space activities, such as the militarization of space, are expected to be addressed.

## Draft Conference Report

Participants at UNISPACE'82 must prepare a report for the U.N. General Assembly containing the observations, conclusions, and recommendations reached by the conference for international action on the items contained in the conference agenda. A draft UNISPACE'82 report, based on national papers submitted by COPUOS members and the views of the UNISPACE Advisory Committee, was prepared by the Secretary-General of the conference and COPUOS (which has been designated as the preparatory committee for UNISPACE'82). The report was distributed to COPUOS members and opened for discussion.

At the last COPUOS meeting (Mar. 22- Apr. 2, 1982), the second version of the draft report was discussed. At the end of the session, only 15 of more than 400 paragraphs remained in dispute. Those paragraphs primarily concern militarization of space, technology transfer, and geostationary orbit (GEO).

The U.S. position is that UNISPACE'82 is not a forum for the discussion of the militarization of space because it is not within the jurisdiction of COPUOS. In fact, a U.N. meeting on disarmament in the summer of 1982 is expected to address some of these issues. Other nations insist that military space activities are endangering the development of space for peaceful activities and therefore are properly within the jurisdiction of the conference.

Many UNISPACE participants see the transfer of space technologies from industrialized to developing nations as an important aspect of the draft report. Developing nations would like a formulation of international mechanisms to ensure that technological developments are available to all nations. The United States has promised funding for technical assistance programs, but these promises have not been fulfilled due to questions about how much money the U.S. should contribute and what mechanism should be used for funding.

A similar issue in dispute is the controversy over geostationary orbit (GEO) which exists 35,800 kilometers above the equator. A satellite placed there will maintain the same position relative to any point on Earth. GEO is a finite natural resource, because there is a limit on how many satellites can be usefully placed there before they interfere with each other. Developing countries would like to see a regulated distribution of these slots to all countries on an equitable basis. The United States and some other countries believe the problem can be solved by technological advances and that to assign frequencies and slots to all countries, regardless of their ability or intent to use them, would unnecessarily restrict access to GEO.

COPUOS will not meet again before UNISPACE'82, so these items will have to be resolved at the conference itself. This may be difficult since there will be more than twice as many countries involved at UNISPACE than at COPUOS (which has 53 member states). A final version of the draft report noting the areas in disagreement was issued on Apr. 20, 1982.

Another aspect of the draft report is a proposal to create a United Nations Centre for Outer Space. The Centre would have a variety of duties in coordinating space activities within the U.N. system. Some countries have expressed concerns over the duplication of duties of existing U.N. departments and agencies. The United States has indicated interest in the concept of the U.N. Centre, but has questioned how the organization would be funded.

## U.S. Preparations

The U.S. national paper for UNISPACE'82 reviews aspects of the civil space program of interest to the world community, in particular, the developing countries. It discusses the use of satellite remote sensing and the sharing of U.S. data from Landsat and meteorological satellites and covers U.S. experimentation on, and demonstration and operation of, various space systems such as INTELSAT, INMARSAT and the space shuttle. According to the document, the United States will continue to transfer "spinoff" technologies resulting from space programs to other countries and industries. The paper does not call for any dramatic initiatives by the United States at UNISPACE'82. All national papers were supposed to be submitted in the spring of 1981 to assist in the preparation of the UNISPACE draft report, but the U.S. paper was not submitted until March 1982 (because of our selective boycott of UNISPACE'82 preparations). As a result, U.S. views that might have been considered during preparation of the draft UNISPACE conference report were not taken into account.

The State Department established an office for the U.S. UNISPACE Coordinator in February 1982. Headed by Ambassador Gerald Helman, this office is responsible for all U.S. preparations for UNISPACE'82 and is currently in the process of selecting a delegation for the conference. Mr. James Beggs, Administrator of NASA, has been named as head of the delegation. The State Department is also coordinating plans for the U.S. exhibit at UNISPACE'82. NASA and the private sector will play equal roles in presenting this visual display of American involvement in outer space activities. As of June 1, 1982, ten companies had agreed to participate in the exhibit; the Air Force will provide air transportation to Vienna for the exhibits.

The United States decision to boycott some of the UNISPACE preparations delayed acquisition of exhibition space at the conference. However, the U.S. has managed to secure a minimum of 2,000 square feet at the main exhibition center, a space equal to that of the Soviet Union.

## ISSUES FOR CONGRESSIONAL CONSIDERATION

From the U.S. point of view, the UNISPACE'82 conference will serve a worldwide educational function, attracting the attention of the media and bringing together experts for discussions. As a matter of U.S. policy, UNISPACE'82 is considered a technical conference and only technical issues, such as utilization of remote sensing data for specific applications, should be discussed. However, it is likely that political and legal issues concerning outer space will be addressed as well, as they have been in other international meetings. These issues include:

-- Increasing national and international concern that space is becoming militarized (weaponized), and that the arms race may spread into space.

-- The controversy over whether countries should have the right of prior consent over distribution of remote sensing data about their territory, and reception of programs from direct broadcast satellites.

-- Concerns of the developing countries about being frozen out of access to space resources, including use of geostationary orbit and resources on the Moon and asteroids.

-- The desire of developing nations to receive technical assistance from developed countries to allow them to benefit from space activities.

-- The controversy over utilizing nuclear power sources in space.

-- The proposal to establish a United Nations Centre for Outer Space.

-- Proposals to have the United Nations control international reconnaissance and/or remote sensing satellites.

The State Department has said that it is highly probable that the U.S. delegation will not be named until six weeks before UNISPACE 82 convenes, although the head of the delegation has been chosen already. The question arises as to how well-prepared the delegates will be, both in terms of becoming acquainted with U.S. positions on various issues and being able to work together cohesively.

The U.S. Coordinator for UNISPACE, Ambassador Helman, has commented that the State Department intends to recruit a wide range of individuals to comprise the delegation, including astronauts, scientists, and policy experts as well as representatives of the government and private sector. The official delegation is expected to include 30-40 individuals. Helman has predicted that the composition of the U.S. delegation will be used as a model by many other nations in creating their own delegations.

Congress may wish to consider the following specific issues concerning U.S. preparations for UNISPACE'82:

1) The U.S. coordinator for the conference has stated that there will be

no "dramatic" initiatives by the United States at Vienna. Should the United States use UNISPACE'82 as an opportunity for demonstrating U.S. willingness for international cooperation in space activities? One suggestion that has been made is that the United States propose creation of an international (probably United Nations) center for disseminating remote sensing data. Another possibility is support of the proposal for creating a U.N. Centre for Outer Space.

2) If the U.S. delegation is supposed to serve as a model for other delegations, why is the naming of the group being delayed until July? Can and should the U.S. delegation be named sooner? What Members of Congress will be on the U.S. delegation?

3) What issues will be deemed important in briefing the delegation? What position papers, if any, are being prepared for members of the delegation?

4) Should a Public Advisory Committee be established to provide input and balance to the preparatory activities of the State Department for UNISPACE'82?

5) What coordination exists between preparations for UNISPACE'82 and other international conferences that may deal with some of the same topics (such as International Telecommunication Union conferences which will debate utilization of GEO)?

## HOUSE SCIENCE AND TECHNOLOGY COMMITTEE HEARINGS

The House Science and Technology Committee's Subcommittee on Space Science and Applications has scheduled hearings on UNISPACE'82 for July 14, 1982. Witnesses will include: James Beggs, Administrator of NASA and Chairman of the U.S. Delegation to UNISPACE'82; Gerald Helman, U.S. Coordinator for UNISPACE'82; Jean Wilkowski, former U.S. Coordinator for the U.N. Conference on Science and Technology for Development (held in 1979); and either Yash Pal, Secretary-General for UNISPACE'82 or Jerry Greg, Deputy Secretary-General for UNISPACE'82.

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# PREPRINT

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## Issues in Implementing the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies

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# ISSUES IN IMPLEMENTING THE AGREEMENT GOVERNING THE ACTIVITIES OF STATES ON THE MOON AND OTHER CELESTIAL BODIES

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## Abstract

Issues will arise in implementing the Moon Agreement if it enters into force because; general principles of space law have been formulated far in advance of applying space science and technology to exploitation of the natural resources of the Moon and other celestial bodies; the details of operational management for a specific function have been projected into the future for solution; philosophical political principles are not matched by technical and economic requirements; lack of definitions for basic terms increases speculation; and some opinion holds that the 1967 Treaty on Outer Space is sufficient. Major issues arising for discussion are the legal status of understandings by the UN Committee on the Peaceful Uses of Outer Space; the definition and implications of "the common heritage of mankind"; the probable nature of a future international regime; the meaning of equitable sharing of benefits derived from exploitation; and ensuring development of an harmonious body of space law. Guidelines for the future development of space law include realistic coordination of technical requirements with legal measures; avoidance of compromises so general as to create widely differing interpretations; achieving universal adherence to international space law.

## I. Introduction

The Moon Agreement was adopted by the United Nations General Assembly on December 5, 1979 and recommended to States for signature and ratification on December 18, 1979. The first six nations to sign the Agreement were Chile on January 3, 1980 France on January 20, 1980, Romania on April 17, 1980, the Philippines on April 23, 1980, Austria on May 21, 1980, and the Government of Morocco on July 25, 1980.[1] It seems likely that more nations will add their signatures to the Agreement and when five States have deposited their ratification documents with the UN Secretary General, the treaty will go into force. Since decisions to approve the treaty text were made by consensus and without voting by the Committee on the Peaceful Uses of Outer Space (July 3, 1979),[2] the Special Political Committee (November 2, 1979),[3] and the General Assembly (December 5, 1979),[4] presumably all issues were resolved. The question now is why issues can be perceived in the implementation of this treaty?

There are several reasons why new issues, different from those which were settled by the Committee on the Peaceful Uses of Outer Space (COPUOS), can be identified as requiring analysis for the future. First, space law has been formulated by this treaty considerably in advance of the technology and political/economic decisions to commit resources to this new function of exploiting the natural resources of the Moon and other celestial bodies. Second, the treaty consists of general principles which are to be applied to a specific operational function but leaves the details of management to be worked out at a later date which is also indefinite. This method of approaching a function leads to speculation about the nature of organization and management, with widely differing conclusions. Third, there are philosophical and political principles used as the basis for some conclusions which omit technical and economic elements integrally involved in operating any program requiring the application of space science and technology. Fourth, the lack of definitions in the treaty leads to differing assumptions concerning the meaning of such terms as "natural resources", "the common heritage of mankind", "international regime", "equitable sharing of benefits derived from exploitation", "developing countries" and "celestial bodies". Fifth, space law for the Moon and other celestial bodies already exists in the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.[5] However, some commentators who are unfamiliar with this international space law, which went into force on October 10, 1967, question certain provisions in the Moon Agreement which are quoted from the 1967 Treaty. While this point can be easily cleared up, the same circumstance (of repeating 1967 Treaty) has produced a sizeable reaction that space law for the Moon and other celestial bodies is already covered by the 1967 Treaty and that an additional agreement is unnecessary.

The issues that are being discussed imply differences of opinion which can affect future implementation of the Moon Agreement, and it is therefore necessary to identify and analyze these interpretations.

## II. Major Issues Relating to Future Implementation of the Moon Agreement.

1. Legal Status of Understandings by the Committee on the Peaceful Uses of Outer Space. The report of COPUOS on its 22nd session includes a section on the "Draft Treaty Relating to the Moon". The Legal Subcommittee had not been able to reach a consensus on the draft text of the Moon Treaty during its 18th session (March 12 to April 6, 1979) and had expressed hope that agreement could be reached by COPUOS during its 1979 session.[6] During that session COPUOS agreed to several amendments and incorporated them in the treaty text. There were some points, however, which did not become amendments, largely because their inclusion might have damaged the consensus that was emerging on the total package which had been worked out in an Austrian draft. These points became three "understandings" of interpretation by COPUOS.[7]

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*President, Theodore Von Karman Memorial Foundation, Member International Academy of Astronautics and AIAA.

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Article I, paragraph 1 of the Moon Agreement text provides that "the provisions of this Agreement relating to the Moon shall also apply to other celestial bodies within the solar system, other than the earth, except in so far as specific legal norms enter into force with respect to any of these celestial bodies." COPUOS related this principle to paragraph 1 of Article 11 which provides that "The moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this Agreement, in particular in paragraph 5 of this article." Paragraph 5 of Article 11 provides for the establishment of an international regime when exploitation of the natural resources of the moon and other celestial bodies is "about to become feasible" but states that this provision must be implemented in accordance with article 18 of the Agreement which provides for two methods of reviewing the Agreement in ten or five years' time. The official COPUOS Understanding is as follows:

> The committee agreed that by virtue of article I, paragraph 1, the principle contained in article XI, paragraph 1, would also apply to celestial bodies in the solar system other than the Earth and to its natural resources. (Paragraph 62).

This is a significant interpretation regarding natural resources of celestial bodies, and it is part of the negotiating history, but its form--and the fact that this COPUOS understanding (as well as the other understandings) is usually omitted when the Moon Treaty text is distributed,--raises the issue of the exact legal status of such an understanding. When the General Assembly voted on the treaty text, specific reference was made to the COPUOS understandings as paragraphs 62, 63, and 65, which could tend to strengthen the status of the understandings;[8] nevertheless, this is an issue which can arise in the future to create problems, and when analysts first read these understandings and realize their importance, they wonder why these points are not included in the treaty text.

The delegates to the 1979 COPUOS session thought it was necessary to clarify article I, paragraph 2 which provides that "For the purposes of this Agreement references to the moon shall include orbits around or other trajectories to or around it." In response, COPUOS recorded this understanding:

> Following a suggestion for clarification of article I, paragraph 2, the committee agreed that the trajectories and orbits mentioned in article I, paragraph 2 do not include trajectories and orbits of space objects in Earth orbits only and trajectories of space objects between the Earth and such orbits. (Paragraph 63).

This means that trajectories to the Moon--and other celestial bodies--and orbits around the Moon are covered by the Agreement, but not covered are earth-orbiting spacecraft and trajectories from the earth to orbits around the earth. That the Earth is in orbit around the sun does not alter the fact that the Moon Agreement does not apply to Earth orbits and trajectories from the Earth into Earth orbits. This is a very important point and yet it is not included in the treaty text but has only the form of a Committee understanding, again raising the possibility of space law that could be applied to future problems that cannot now be precisely foreseen. This situation apparently stems from the attempt to formulate space law long in advance of actual space technological applications.

The third understanding concerns Article 7 which has three paragraphs designed to prohibit disruption of the existing balance of the environment of the Moon and other celestial bodies, their harmful contamination as well as contamination of the Earth, informing the UN Secretary General of measures adopted to prevent environmental harm, as well as notification of placing radioactive materials on the Moon. In additon, the article provides that areas with special scientific interest shall be reported to the Secretary General so that they may be designated as international scientific preserves and protected. The COPUOS understanding is that--

> Following a suggestion for further clarification of article VII is not intended to result in prohiting the exploitation of natural resources which may be found on celestial bodies other than the Earth but, rather, that such exploitation will be carried out in such a manner as to minimize any disruption or adverse effects to the existing balance of the environment. (Paragraph 65).

Since this understanding relates to an issue that has already been raised as to whether or not the Moon Agreement includes a moratorium, or an implied moratorium, on exploitation prior to establishment of an international regulatory regime, it is evident that this point is sufficiently important that it might have become a more integral part of the treaty-making process than that of an understanding. It is clear that there is no legal moratorium in the Moon Agreement prohibiting the exploitation of natural resources of the Moon and other celestial bodies between the present time and the establishment of an international regime, but some would argue that it would be even more certain if the wording of paragraph 65 had been included in the treaty text.

In discussing the avoidance of harmful contaimination in connection with article VII of the Austrian text, COPUOS considered whether or not to include "especially nuclear material", but this suggestion could not achieve consensus and consequently was not adopted, as explained in paragraph 64.

The COPUOS understandings are an essential part of the Moon Agreement's negotiating history, and yet their precise legal status is not defined for all possible future contingencies. The negotiating history is also recorded in summary records of the Legal Subcommittee (1970-1978) and it should be noted, parenthetically, that unless such records are reinstated in the future, after having been omitted for economic reasons during 1980, it will not be possible to follow the line of reasoning in UN treatymaking on outer space matters. Press releases cannot take the place of official negotiating records.

2. The Common Heritage of Mankind. In Article 11 of the Moon Agreement the general concept of "the common heritage of mankind" has been limited by specific provisions, thus giving rise to issues

which will be analyzed for many years to come. Paragraph 1, for example, provides that "the moon (and this includes "other celestial bodies") and its natural resources are the common heritage of mankind..." a general principle implying that every person in the world has a stake in this heritage; but the paragraph continues with specifics: "which finds its expression in the provisions of this Agreement, in particular in paragraph 5 of this article." Thus the general principle is to be limited in its implementation. According to paragraph 5, only States Parties undertake to establish an international regime with "appropriate procedures"; the regime is to be concerned only with governing the exploitation of the natural resources of the moon and other celestial bodies when exploitation "is about to become feasible"; and this provision "shall be implemented in accordance with article 18 of this Agreement." Article 18 includes two methods for reviewing and/or revising the Moon Agreement in the future, and only one applies to States Parties to the treaty. This is the procedure whereby, any time after the treaty has been in force for five years, one-third of the States Parties (with the concurrence of a majority of States Parties) can request the UN Secretary General to convene a review conference of States Parties. This could result in a restricted number of States, the number depending upon those nations that had ratified the treaty. There are several issues that come to the surface: is the common heritage of mankind to be administered by a limited, and possibly small, number of States? Regardless of the number, they cannot establish an international regime before exploitation is about to become feasible without violating the treaty. Their functions are limited to those involving exploitation of natural resources, and if they are not States with capabilities for using space science and technology in applications involving the Moon and other celestial bodies, how will they determine when exploitation "is about to become feasible"?

Estimates are that it will be many years before it is possible to exploit the natural resources of the Moon and other celestial bodies, and, in any event, a period of scientific investigation and research must precede any exploitation. My own estimate is that the procedure in Article 18 for action by the UN General Assembly to review the Moon Agreement will inevitably come before States Parties can bring about a review conference. This would mean that ten years after entry into force, the question of reviewing the Moon Agreement would be included in the provisional agenda of the General Assembly which would decide "in the light of past application of the Agreement, whether it requires revision." If the General Assembly so decided, then it could request that the question of revision be placed on the agenda of COPUOS which would logically lead again to negotiation by the Legal Subcommittee. Although the General Assembly, in making its decision, needs to consider only the "past application of the Agreement", all elements of the situation could be discussed within the COPUOS framework and need not be confined to those States that are Parties to the treaty.

According to the Moon Agreement, the common heritage of mankind principle is confined to, and limited by, this document and does not take its meaning from any other source. Whether or not the principle is compared with and becomes interpreted according to prevailing concepts concerning the law of the sea depends upon the extent to which planning for an operational function using space science and technology is differentiated because of its unique aspects, and tailormade arrangements are devised for effective, efficient operations. Issues will surface from this problem: how should general principles be translated into specific arrangements which take account of the operational requirements of space science and technology in providing benefits for mankind as a whole?

3. Equitable Sharing. Future issues can be expected to emerge with regard to one of the purposes of the international regime, "equitable sharing", as provided in Article 11 (7) (d):

> An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.

Equitable sharing is not the same as equal sharing, and in this context suggests some arrangement such as that in the Convention on the International Maritime Satellite Organization (INMARSAT)[9] which provides, in Article 8, that "The Organization shall be financed by the contributions of Signatories. Each Signatory shall have a financial interest in the Organization in proportion to the investment share which shall be determined in accordance with the Operating Agreement." The Operating Agreement provides, in Article V (1) that "Investment shares of Signatories shall be determined on the basis of utilization of the INMARSAT space segment. Each Signatory shall have an investment share equal to its percentage of all utilization of the INMARSAT space segment by all Signatories. It should be noted that the UN specialized agency, the Inter-Governmental Maritime Consultative Organization (IMCO) played a leading role in INMARSAT negotiations and that the IMCO Secretary General is the depositary for the Convention.

The exact manner in which "equitable sharing", as provided in the Moon Agreement, would be worked out cannot be determined in detail until an international regime is established, and this cannot be done until exploitation of natural resources "is about to become feasible." Meanwhile, this is an issue for discussion, particularly when it is considered that the States Parties are to share equitably "in the benefits derived from those resources" while simultaneously keeping in mind "the interests and needs of the developing countries." There is no definition of "developing countries" and the treaty may not become applicable in this respect for 30 to 50 years, by which time, or hopefully before, many developing countries will have become developed. The most pessimistic outlook for the future would result from an assumption that the developing countries of today will have made no progress by the turn of the century and even beyond. Not only is the international regime to consider developing countries, but it is also to give "special consideration" to "countries which have contributed either directly or indirectly to the exploration of the Moon." This adds two more categories of nations, but in either case their space activity is that of exploration and not use as provided in the 1967 Treaty on Outer Space. The generality of the main purposes of the international regime as stated in the Moon Agreement will undoubtedly lead to speculation as to the manner in which they are to become specific, and it may not be possible to provide the specifics prior to the application of space technology to exploitation of the natural resources of celestial bodies.

4. Compatibility of the Moon Agreement with Space Treaties in Force. Numerous issues can arise for analysis in determining whether or not all provisions in the Moon Agreement are in harmony with previous space treaties, particularly with the 1967 Treaty on Outer Space. This exercise should not be viewed as detrimental but as essential to the task of formulating a harmonious body of space law. The 1967 Treaty provides guidelines for outer space, the Moon and other celestial bodies, whereas the Moon Agreement omits outer space as a spatial area and is confined to the Moon and other celestial bodies. If States are Parties to one treaty and not the other, a certain hiatus can be expected in the application of guiding principles. There was an assumption by some commentators that the 1967 Treaty did not cover the exploitation of natural resources because they under-estimated the meaning of "use" as provided in the 1967 Treaty, concluding that use does not cover all activities; whereas others are certain that the 1967 Treaty made an outstanding contribution to space law by including "use" as well as "exploration" as general terms applicable to all activities in outer space, including the Moon and other celestial bodies.

There are numerous references in the Moon Agreement to former space treaties and in some cases States which ratify the Moon Agreement are bound by provisions in former treaties. For example, Article 9 of the Moon Agreement provides that States Parties may establish manned and unmanned stations on the Moon and they are not to "impede the free access of all areas of the moon...of other States Parties..in accordance with the provisions of this Agreement or of Article I of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies." This gives States Parties to the Moon Agreement a choice of observing its provision or the 1967 Treaty whether or not they have ratified both treaties. If a State ratified only the Moon Agreement, could it be bound by Article I of the 1967 Treaty?

Article 10 of the Moon Agreement seeks to safeguard the life and health of persons on the Moon and they shall therefore regard any person as an astronaut "within the meaning of article V" of the 1967 Treaty "and as part of the personnel of a spacecraft within the meaning of the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space." This means that States ratifying the Moon Agreement are expected to comply with provisions of two other treaties even though they have not ratified those treaties.

Article 12, paragraph 2 requires States that become Parties to the Moon Agreement to comply with Article 5 of the Astronaut Agreement as related to "vehicles, installations and equipment or their component parts found in places other than their intended location." Here, again, States Parties to the Moon Agreement are obligated to observe another agreement which they may not have ratified.

Article 16 on the status of international intergovernmental organizations more clearly provides that if States are Parties both to the Moon Agreement and the 1967 Treaty, as well as the organization in question, then they may take appropriate steps to ensure that the organization declares its acceptance of the rights and obligations provided in the Moon Agreement.

It is not possible to foretell whether or not issues may develop from these provisions which require compliance with treaties to which States Parties to the Moon Agreement may not be members. Perhaps these particular articles are not apt to become controversial, but the main point to note is that in striving for an harmonious body of space law we should make every effort to ensure the membership of all States in every space treaty.

5. Appropriate Body to Formulate an International Regime. According to Article 18 of the Moon Agreement, an international regime can be planned by States Parties any time after the treaty has been in force for five years, or as a result of action in ten years by the General Assembly. Under the first option, it is possible for a small group of States Parties to control planning for operations which affect "the common heritage of mankind." Under the second procedure provided in Article 18, it is possible that planning for operations of a technological space system would be assigned to the Legal Subcommittee of COPUOS. In any event, it will be many years before feasibility for exploiting natural resources can be established and thus we have time to consider additional approaches to this problem. The existing model which is apt to be most adaptable is that of INMARSAT which affords a realistic example of how to relate the attainment of general objectives to institutional arrangements. This task should not be regarded as primarily an issue for argument but as an opportunity for sober, objective analysis of the most effective technical means required for the smooth operation of a necessary function.

The method used thus far to formulate space law has been outstandingly successful as compared to the law of the sea. The law of the sea is being negotiated from a composite text[10] which includes every conceivable problem, a method which naturally raises a maximum number of questions and takes much longer to achieve international agreement. In contrast, space law started from the charter 1967 Treaty on Outer Space and as different problems developed new treaties were formulated to meet specific situations. Space law was expanded to cover assistance to astronauts, their return and the return of space objects; liability for damage from space objects; and registration of space objects. Similarly, space law as developed by the International Telecommunication Union (ITU) is tailormade for space communications. The specific function of space communications is further provided for by INTELSAT and INTERSPUTNIK. Navigation has been improved by using satellites, and INMARSAT takes "into account that a very high proportion of world trade is dependent upon ships" and therefore provides "for the benefit of ships of all nations through the most advanced suitable space technology available, for the most efficient and economic facilities possible consistent with the most efficient and equitable use of the radio spectrum and of satellite orbits."[11]

In addition, space law has been formulated during the past 22 years in numerous bilateral and multilateral agreements on specific programs requiring the use of space technology.

The only conclusion that can be drawn is that extraordinary expertise has been demonstrated in handling specific functions which can be improved by the use of space science and technology and this has brought about a remarkable degree of international cooperation in the peaceful uses of outer space. This same ability can be used in working out viable operational and economic arrangements for the Moon and other celestial bodies, and if we are temporarily overcome by this task, it is only because we are trying to formulate space law many years, perhaps decades, in advance of the actual commitment of resources to the Moon and other celestial bodies. When this attempt was first started in 1970 and 1971, there seemed to be a pressing need for space law because of the active Moon exploration programs of the United States and the U.S.S.R. during the 1960s, and it could not be foreseen that such programs would diminish during the 1970s. In the case of all other functional space programs, law and technology developed in tandem or not very far apart and this was an essential element in our success. As these two elements draw nearer together in the future, we will be able to adjust an operating technology according to efficient and equitable procedures.

## III. Guidelines for the Future Development of Space Law

It is important to establish criteria for the formulation of space law. As we plan for the present and future, keeping in mind patterns of success and failure in the past, the following guidelines are recommended:

1. Realistic coordination of technological and economic requirements with appropriate legal measures.

2. Recognition that new treaties must be compatible with space treaties and agreements already in force; there should be no built-in conflicts in provisions formulated for the future conduct of space activities. Implementation of this recommendation requires the codification of all space law.

3. Awareness that the nature of space law demands attention not only to UN drafted treaties but also to bilateral and multilateral agreements concluded outside the United Nations framework, e.g., the European Space Agency, INTELSAT, etc.

4. Recognition that different patterns of international space cooperation can develop with regard to relationships with the United Nations, e.g., the International Telecommunication Union, UNESCO, the World Meteorological Organization, the Food and Agriculture Organization, the International Maritime Satellite Organization, etc.

5. Attention to the fact that there are interrelationships between international space law and national laws.

6. Acknowledgement that consensus should not be achieved on compromises that are so general and undefined that widely differing interpretations can reasonably result.

7. The Legal Subcommittee of COPUOS, which has a highly successful record of accomplishment, should not be expected to formulate space treaties on every space application, and its workload can include discussions of subjects requiring background information and clarification, particularly in integrating technical and legal matters.

8. Attention to the necessity of achieving universal adoption of the several major treaties which make up the body of international space law.

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## References

1. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies: History and Analysis. By Eilene Galloway. Committee print. Senate Committee on Commerce, Science, and Transportation. 96the Congress, 2d session. May 1980. Part 2 of this document contains the texts of all documents mentioned in the Moon Agreement. 264 p. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

2. Report of the Committee on the Peaceful Uses of Outer Space, General Assembly Official Records: Thirty-Fourth Session, Supplement No. 20 (A/34/20). (Session June 18 to July 3, 1979). United Nations New York, 1979. 42 p.

3. International Cooperation in the Peaceful Uses of Outer Space. Report of the Special Political Committee. A/34/664. November 12, 1979.

4. Resolution adopted by the General Assembly on the report of the Special Political Committee (A/34/664). 34/68 on Agreement Governing the Activities of States on the Moon and Other Celestial Bodies. A/RES/34/68. December 14, 1979, pp. 1-2, Annex pp. 3-12.

5. 18 U.S.T. 2410 T.I.A.S. 6347, 610 U.N.T.S. 205.

6. Report of the Legal Subcommittee on the Work of its Eighteenth Session, March 12 to April 6, 1979) A/AC.105/240. April 10, 1979.

7. Op. Cit., (reference 2), pp. 11-12.

8. Op. Cit., (reference 4).

9. Convention and Operating Agreement on the International Maritime Satellite Organization (INMARSAT). The texts of these agreements, as well as other texts of space law treaties are in "Space Law: Selected Basic Documents: Second Edition". Committee Print. Senate Committee on Commerce, Science, and Transportation. 95th Congress, 2d session. December 1978. 600 p. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. INMARSAT Agreements on pp. 407-447.

10. Informal Composite Negotiating Text/Revision 1. United Nations Third Conference on the Law of the Sea. Eighth session, Geneva, March 19 to April 27, 1979. A/CONF.62/WP.10/REV.1. April 28, 1979. 140 p. 7 annexes.

11. *Op. Cit.*, (reference 9), pp. 407-447.

# UNISPACE '82

## A BACKGROUND REPORT

CONGRESS OF THE UNITED STATES
OFFICE OF TECHNOLOGY ASSESSMENT

JULY 14, 1982

# UNISPACE '82

## A Background Report

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This background paper was requested by the Committee on Science and Technology of the U.S. House of Representatives, and the Joint Economic Committee as part of a major assessment of International Cooperation and Competition in Civilian Space Activities. It presents the major technical, economic, and political issues that will confront the United States at UNISPACE '82.

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# UNISPACE '82 - A BACKGROUND REPORT

## 1. Introduction and Summary of the Issues

UNISPACE '82, the second U.N. Conference on the Peaceful Uses of Outer Space, will be held in Vienna, Austria on August 9-21, 1982. As a conference that will consider the state of space technology and its future use for the world, particularly in the developing countries, UNISPACE '82 provides a challenge and an opportunity for the United States.

It provides a challenge because UNISPACE '82 is a forum in which an extensive series of demands will be made on the United States and other industrialized countries by developing nations. The conference will necessarily deal with many issues affecting U.S. space policy, and U.S. policy towards the third world and multilateral organizations. The ensuing debates and the resulting Conference Report will affect the course of other international conferences dealing with outer space and space technology such as the International Telecommunications Union (ITU) plenipotentiary in Nairobi in September 1982 and the Region Two Administrative Radio Conference in June 1983 (RARC '83).

On the other hand, UNISPACE '82 provides an opportunity to educate and influence developing countries about the scope of U.S. technology and its capacity to aid them in developing their resources. Above all, UNISPACE '82 is an occasion on which highly placed delegates from over 100 nations will meet for an extended period to discuss a single set of issues. As such, it offers an opportunity for the United States to explain its positions and influence those of other countries, while simultaneously gaining insight into the interests and concerns of others. At UNISPACE '82, the debate that transpires on the conference floor may be less important than information gained and influence exerted on the side-lines. It goes without saying that both the composition of the U.S. delegation and the quality of the U.S. exhibit are critical if the United States is to make the most of the conference. Political, technical, and business acumen will be needed.

UNISPACE '82 will in many respects celebrate the fact that we now consider access to space and the use of space technology relatively routine. In the 25 years since the beginning of the space age, several countries, in addition to the United States and the Soviet Union, have instituted vital, expanding space programs. Furthermore, many countries have become direct or indirect users of space systems. This represents a major change from the first UNISPACE Conference in 1968. Although the primary focus of UNISPACE '82 will be on cooperation in space for peaceful purposes, competition between nations for commercial markets and political prestige will also play an important role[*] and make cooperation in some areas difficult.

In the United States, few are aware of the conference and of its potential importance to this country's space policy and the future of its aerospace industry. In the wake of other recent U.N. conferences at which the United States was subject to sharp attacks, many U.S. leaders view this conference with suspicion. Consequently they seek to minimize its importance in the hope of limiting the damage it might do to U.S. political and commercial interests. However, the United States would limit the potential damage most effectively by thoroughly preparing for UNISPACE '82 and participating in it actively.

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[*] Civilian Space Policy and Applications, Office of Technology Assessment Report OTA-STI-178, June 1982.

How will the United States respond to the challenge and opportunity the conference presents? Will it respond actively and attempt to reap as many benefits as possible, or reactively by minimizing the importance of UNISPACE '82 for U.S. interests? The U.S. approach to UNISPACE '82 is of concern in large part because U.S. preparation for other international technical conferences has often been poorly planned and coordinated.* After a slow start due to disagreement over U.S. participation, the United States has assembled an interagency planning group chaired by Ambassador Gerald Helman and a delegation headed by National Aeronautics and Space Administration (NASA) administrator James Beggs. Both government and private sector exhibits are planned. It remains to be seen, however, whether the United States will be adequately prepared to use UNISPACE '82 effectively.

The UNISPACE '82 agenda is to prepare a report for the U.N. General Assembly stating the present and projected state of space technology and its applications, with emphasis on the developing countries. The report will conclude with recommendations for future action by the United Nations, its specialized agencies, and its member states. As such it will serve as a statement of the interests and aspirations of the developing world with respect to space science and technology.

UNISPACE '82 will therefore also constitute a forum for political manuevering and debate. Since the formal agenda has been shaped largely by the interests of developing countries, the United States might further its own interests if it were able to diffuse some of the rhetoric at the conference by proposing one or more U.S. cooperative initiatives in space. The

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*OTA report Radiofrequency Use and Management: Impacts from the World Administrative Radio Conference of 1979, OTA-CIT-163, January 1982; H.R. (1957); S(2469), 97th Congress.

Administration is considering initiatives to offer at UNISPACE '82. OTA has also identified several initiatives that the United States could propose (elaborated in Section 7 of this background paper).

This background paper was requested by the Committee on Science and Technology of the U.S. House of Representatives, and the Joint Economic Committee as part of a major assessment of International Cooperation and Competition in Civilian Space Activities. It presents the major technical, economic, and political issues that will confront the United States at UNISPACE '82.

**Section** 2 of this background paper summarizes briefly the current state of applications technology in the world. Cooperation, competition, and the international agreements that are in effect to regulate space are the subjects of **Section 3.** **Section** 4 attempts to put the UNISPACE '82 conference in the political context of world affairs that may affect it generally and specifically. The major issues are discussed in **Section** 5, and possible outcomes explored in **Section 6.** Finally, **Section** 7 raises some possible initiatives that the U.S. delegation could present at UNISPACE '82.

## Summary of Major Issues

The primary issues of UNISPACE '82 can be divided into two categories: the underlying political and economic concerns at the conference, and issues directly related to specific space applications technologies. There is considerable overlap across issues; within these broad categories, the issues that follow are discussed in more or less priority order. They are explored in detail in Section 5.

Issues

| Interest Groups | Direct Broadcast Satellites | Geostationary Orbit | Remote Sensing | Weaponization | United Nations Center for Outer Space |
|---|---|---|---|---|---|
| United States | Strong support of technology development and participation by the private sector. Advocates free flow of information. Opposes introduction of prior consent regime. | Advocates first-come, first-served regime with decisions made on technical basis by the ITU. | Advocates unrestricted sensing with open data dissemination for civilian systems. | Draws distinction between weapons and military support systems. | Ties support of center to requirement that it not increase U.S. contribution to U.N. |
| Other Developed (e.g. France, Japan) | Some support U.S., others favor prior consent for right to broadcast but not for program content. | Same as U.S. position except with strong emphasis on regional cooperation. | Willing to negotiate a prior consent for remote sensing, limitations on dissemination, and resolution. | Some take position of LDC's, others support U.S. position. | No consistent viewpoint. |
| Soviet Bloc | Advocate regime where receiving state retains control over right to broadcast and program content. | Advocate first-come, first-serve. | Advocate unrestricted sensing and open data dissemination on resolutions greater than 50 M. | Do not acknowledge the existence of military space activities. | Object on basis that outer space affairs division of the U.N. is sufficient. |
| Space Capable LDC's (e.g. China, Brazil, India) | Same as above. | Advocate a priori allocation of orbital slots based on concept of equal access to finite resources. | Advocate prior consent regime for sensing and dissemination, no limit on resolution. Support development of internationally controlled systems. | Recognize some need for military presence (e.g. surveillance), oppose development of "aggressive" systems. | Support on basis that it will increase third world access to space programs, technology, and human expertise. |
| Non-Space LDC's | Same as above. | Same as above. | Same as above, with emphasis on continuity of data at stable, low prices. | Same as above. | Same as above. |

Table 1

## A. Economic and Political Context of the Conference

- **Economic needs of developing countries.**

In a sense, this issue is the raison d'etre of UNISPACE '82. The developing countries want a larger share of the world economy and view access to space technology as necessary to accelerate development and achieve greater parity with industrialized nations. Their desire for economic growth and technological independence is the foundation of such principles as "common heritage of mankind" and demands for guaranteed access to geostationary orbit. The Draft Report explicitly refers approvingly to the conclusions of the 1979 U.N. Conference on Science and Technology for Development (UNCSTD) and argues that space technology can be used to leapfrog obsolete phases of technology development. There will be strong pressure for the industrialized states to provide services and hardware on a preferential basis to developing countries and to institutionalize the means of transfer of space technology within the United Nations. The major question for the United States is how far to go to accomodate such demands, and what might be gained in return. For example, the United States could offer to provide some support for regional learning centers to assist in training personnel to use technology effectively (see Section 7).

The developing countries also have an interest in having their citizens trained in space science and the operation of space technology. This interest could be met in part by offering to train and fly a few "payload specialists" aboard the space shuttle (see Section 7). More importantly, the United States could offer to lead an Integrated Global Study of the

Earth (see Section 7) that would involve all the countries of the world in collecting basic ground data on the atmosphere, the land and the oceans. When integrated with data from satellites, these data would lead to a much better understanding of the physical dynamics of the globe and alert us to harmful large-scale anthropogenic and natural changes in the environment.

- **Militarization or weaponization of space**

Several nations have expressed concern over "the growing dangers of the military uses of outer space."* This concern is raised in several paragraphs of the Draft Report. The 1967 Outer Space Treaty prohibits deployment of weapons of mass destruction (primarily nuclear weapons) in outer space, but according to U.S. and Soviet interpretations, it does not prohibit reconaissance satellites or weather and communications satellite used for military purposes.

There is likely to be considerable debate over this issue at UNISPACE '82, particularly because the Soviets and others have labelled the U.S. space shuttle a weapon, and because some U.S. allies fear that an expanded military role in space might hinder future civilian cooperative ventures in outer space (e.g. a manned space station). Recently there has been a series of official U.S. statements and initiatives that may lend weight to charges that the United States intends to militarize space. These include the President's July 4 Policy Directive which emphasizes national security programs, and the use of the latest shuttle flight to carry a classified DOD payload.* The United States does not consider the shuttle itself as a weapon. Of additional concern to some is the fact that the Soviet Union now operates a first generation anti-satellite weapon (A-Sat) and the United States has one under development; neither system is based in space. There is likely to be a move to ask the General Assembly to remove the issue of the militarization of outer space from the U.N. Committee on Disarmament and refer it to the Committee on the Peaceful Uses of Outer Space (COPUOS) on the grounds that the latter committee has the expertise and the time to consider it, while the former is occupied with more pressing concerns about nuclear disarmament. The U.S. position is that the issue should remain where it is on the grounds that COPUOS doesn't have the expertise to handle the military matters involved. In addition, COPUOS is staffed by the Outer Space Affairs Division of the U.N. Secretariat which is dominated by the Eastern Bloc.

- **Private enterprise in space.**

  The rights and role of private enterprise in outer space is an implicit concern in many issues. Many developing countries, along with the Soviet Union, would like to see restrictions placed on the private sector of states, with strictly private operation of space technology either prohibited or subject to international regulation. In an era when commercial firms have increasing interest in providing services and products in or from outer space, it will be important for the U.S. delegation, where necessary, to seek wording in the conference report to protect the U.S. private sector and to argue against unnecessarily restrictive regimes for outer space.

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*1981 Report of COPUOS, 36th Session, Supp. No. 20 (A/36/20).
*July 4, 1982 White House Fact Sheet on National Space Policy.

- **U.N. Centre for outer space.**

The Centre has been proposed to serve the training and information needs of the developing world. It would not assume the regulatory function of the ITU, nor the treaty drafting and negotiating function of COPUOS. However, it would remove some space activities from the control of the Outer Space Affairs Division (OSAD) of the U.N. Secretariat, which for the foreseeable future will be dominated by Eastern Bloc countries. The Soviets are opposed to the Centre primarily because it would reduce some of their power over outer space affairs in the U.N. structure.

Although the United States is opposed to committing additional funds to the United Nations, or expanding U.N. agencies, it would not oppose the Centre if it were kept small and operating funds were reprogrammed from other U.N. sources. It is not clear that the Centre would be a more efficient way of focussing attention on using space technology for development than the present arrangement in the United Nations. However, it would provide a central location for some activities that are now spread throughout other U.N. agencies. Supporting the Centre concept actively could allow the United States to acquire more influence over U.N. outer space affairs and associate itself with a position broadly supported by developing countires. The United States could provide some economic support for the Centre and its aims at little direct cost to U.S. taxpayers by detailing scientists and technicians to it for specified periods (see Section 7).

- **Nuclear power sources in outer space.**

  The issue of nuclear powered satellites arose in recent years because of Canadian concern over radioactive debris from the downed Soviet satellite Cosmos 954. It has also become of concern to some delegates who incorrectly link satellites having nuclear power sources in low earth orbits with weaponization of space. Although the Soviets use nuclear power sources for some satellites, the United States currently flies no satellites containing nuclear reactors. This issue is unlikely to be discussed extensively at UNISPACE '82. However, the United States might gain by reiterating its position on nuclear reactors in space publically at the conference.

**B. Technology specific issues.**

### Satellite Communications

Telecommunications by satellite raises several critical concerns that are likely to arise at UNISPACE '82. Although each has a technical basis they all have potential ramifications for U.S. relations with other countries.

- **Geostationary Orbit (GSO).** Three problems exist: future overcrowding of parts of the orbit, frequency allocation (also related to orbit overcrowding), and claims of sovereignty by the equatorial nations.

  Developing countries are likely to raise the issues of overcrowding of the orbit and frequencies and to lobby for a priori allocations based on the principle of the equitable use of and access to the orbit. They wish to reserve the lower frequencies of C-band (6/4 GHz) to themselves and move the industrialized countries to Ka-band frequencies of 14/12 GHz and higher because the former make use of simpler and cheaper technology. However, the 2.69/2.56 GHz S-band is available to developing countries and it has seen little use. With the possible exception of the western hemisphere, there appears to be little pressure on 6/4 GHz slots at the present time. The United States opposes efforts to allocate slots in the orbit or frequency prior to actual use. This position is justified on the theory that future technological advances will solve potential overcrowding problems. Claims of sovereignty over the GSO have been made by equatorial countries, but have always been rejected by the developed countries. Although the equatorial nations may attempt to use the issue for political leverage, they are not likely to be taken seriously at UNISPACE '82. One way to diffuse the criticism that industrialized countries will force the developing countries into more expensive technology, is to offer to operate several C-band transponders on the Tracking, Data, and Relay Satellites for the communications requirements of developing countries (see Section 7).

- **ITU regulation.** There may be efforts at UNISPACE '82 to amend or bypass the ITU operating procedures by insisting on the "common heritage" principle, and removing decisions from the ITU to the U.N. General Assembly or other highly political arenas. These issues are likely to be raised at UNISPACE '82, in preparation for the ITU Plenipotentiary in September, 1982. These and other discussions are likely to affect the Region 2 RARC in June 1983. There may also be discussion about changing the formula for funding the ITU to one that would increase the percentage of the U.S. contribution, a move the United States would oppose.

- **Direct Broadcasting Satellite (DBS).** Because DBS techniques have the power to deliver television programs directly to small home or village receivers, they constitute a powerful means for providing educational, health care and other services to isolated areas. However, they also engender grave concern in many countries, developing and developed alike, because they could also be used to impose foreign values on a society. For example, Canada has voiced concern about the potential cultural impact of U.S. television, and Germany objects strongly to Radio Luxemburg's proposed commercial DBS television network. Efforts to promote regulations about prior consent to broadcast and control over program content, both of which the United States opposes, are highly likely at UNISPACE '82. If general agreement concerning the need for regulation of DBS were to occur, it would be of vital interest to Western countries that will be competing to provide DBS systems to the rest of the world. This debate will also almost certainly spill over into the ITU Plenipotentiary and the RARC '83 conferences.

### Land Remote Sensing

- **Prior Consent.** Land remote sensing raises the issues of prior consent, 1) to sense a country and, 2) to distribute information to third parties. Both are highly sensitive political issues, especially for developing and communist countries, if the ground resolution is sufficiently high. Resolutions of 50 meters or more present no problem to most countries. However, considerable resistance to an open skies policy appears somewhere between 10 and 30 meters resolution. On economic grounds, developing countries will also resist allowing high resolution data to be taken and sold to industrialized countries and private firms, particularly if the developing countries lack the computer capacity and sophisticated software to process them on their own. One possible U.S. initiative for UNISPACE '82 is to propose an international remote sensing system whose management would be modeled loosely on the Intelsat communications network (see Section 7).

o **Data continuity.** For UNISPACE '82, maintaining continuity of remote sensing data is more important than the issue of prior consent. The developing countries, many of whom have spent millions of dollars to purchase Landsat receiving stations or to develop processing capabilities, are concerned about the U.S. policy to terminate Government operation of the Landsat program. They have explicitly stated their desire for the United States to continue to make available multispectral scanner data from Landsat. According to current U.S. policy, after termination of the Landsat program, the data flow would have to maintained by the U.S. private sector, if at all. The latter possibility gives foreign governments pause because of the potential for private corporations to use the data collected for their own profit before it could be viewed and processed by developing countries.* Although the developing countries have generally supported technological advances such as higher resolution and greater spectral discrimination, they are also concerned about their own relative lack of sophistication in handling large amounts of remotely sensed data. Thus here as in other areas, the very increases in technological power that would make their economic advancement easier may serve to increase the gap between them and developed nations. The United States could make considerable gains in the developing world and serve its own internal needs for remote sensing data as well, by reversing the decision to terminate Government support of the Landsat multispectral scanner program (see Section 7).

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*See the discussion in Civilian Space Policy and Applications, Op. Cit., pp. 62-64.

## 2. Space Applications Technology and the International Community

Since the inception of spaceflight 25 years ago there have been only two full-scale space powers, the United States and the Soviet Union. Each of these countries has developed and maintained a large and varied program for civilian and military uses. However, in the past ten years other countries have developed various degrees of space capability and/or use for space technologies. These include:

- **France and Japan,** which have expanding national programs that include independent space transportation, communications, remote-sensing, meteorological and space science systems,
- **Canada, Great Britain, and West Germany,** and other industrialized countries that have independent programs in particular areas and also contribute to bilateral and multilateral ventures, primarily through the European Space Agency,
- **India, Brazil, and China,** developing countries with relatively advanced space programs and the eventual aim of developing a variety of indigenous space technologies,
- **a number of individual countries and regional associations** that have, or plan to have, regional satellite communications systems; these include Indonesia (Palapa A&B), India (Insat), the middle-east (Arabsat), Scandinavia (Nordsat), Australia (Australsat),and Columbia (Satcol).

- **many industrialized and developing countries that use space technologies,** primarily through the International Telecommunications Satellite System (Intelsat); the International Maritime Satellite system (Inmarsat); the Intersputnik network (a Soviet-based communications satellite system); the U.S. Landsats (for land optical sensing); and the U.S. and other meteorological satellites.

The following outlines briefly the major national and multinational systems for key space technologies: space transportation, satellite communications, land-remote sensing, and meteorology.

**Space Transportation** - The re-usable space shuttle is intended to be the mainstay of U.S. space launches, both civilian and military, for the foreseeable future. In addition to the shuttle, the United States has several expendable launch vehicles of different sizes. Depending on the shuttle's performance and overall demand for launches, some expendable launch vehicles may be discontinued during the next several years; if demand is great, however, new versions may have to be developed and built.*

All U.S. civilian launches are conducted by NASA. The U.S. policy has been that NASA will launch civilian payloads for any customer, foreign or domestic, on a space-available basis and charge it for the cost of the launch. In the past the United States has launched many scientific and applications payloads for other countries and for Intelsat, and has also carried instruments for other countries on U.S. flights. The shuttle will be the carrier for the European Space Agency's Spacelab.

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*Civilian Space Policy and Applications, op. cit., pp. 75, 290.

The Soviet Union also has several types of expendable launcher and uses them to launch many more payloads annually than the United States. There are reports that the Soviets are developing a larger launch-vehicle as well as a reusable shuttle-type vehicle;* little is known about their future plans due to the extreme secrecy surrounding the Soviet program. The Soviet Union has, on occasion, launched satellites and instruments for other countries, such as India, but does not make its facilities available on a general basis.

The European Space Agency, led by France, has recently developed its own expendable launch vehicle, the Ariane. The Ariane is comparable to mid-sized U.S. and Soviet launch vehicles, and is being marketed on a world-wide commercial basis by a French company called Arianespace.

The Japanese have developed a number of smaller launchers, building on U.S. technology for the Delta launch-vehicle. At present they do not provide launches for other countries, but are likely to do so by the end of the decade.

**Space Communications** - Operation of satellite communications in the U.S. is largely in the hands of private common carriers such as Western Union and AT&T. The uses include voice, data, and TV transmission and will soon involve direct-broadcast TV as well. Comsat Corp. is responsible for international satellite communications as the exclusive U.S. liaison with Intelsat. In the past, research and development was largely conducted by NASA, but more recently NASA has stayed out of advanced R&D. There is presently controversy over resumption of NASA research, particularly for 30/20 GHz systems.*

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*Civilian Space Policy and Applications, op. cit., p. 207.
*Civilian Space Policy and Applications, op. cit., pp, 48-51.

Research on 30/20 technology and operational direct broadcast satellites (DBS) is more advanced in both Europe and Japan than in the U.S. In Europe, regional and/or national satellite systems are planned by England, France, Germany, and Italy and one private firm, Radio Luxemburg. These will include DBS and highspeed business data services. In Japan, both 30/20 GHz and DBS systems have been test-flown and operational uses are envisioned in the near future. European and Japanese firms are interested in marketing complete satellite systems and see a large potential market in both developed and developing countries; Japan, in particular, is already well-established as a producer of ground receivers.

As mentioned, several regional satellite systems exist, or are planned for the near future, notably in the Middle East, India, Indonesia and South America. At present, many developing countries depend heavily on Intelsat for both international and domestic communications.

**Land Remote-Sensing:** The only currently existing civilian global land remote-sensing system is the U.S. Landsat system, which for 10 years has provided multispectral scanner (MSS) data to domestic and foreign customers. Twelve foreign countries have set up their own ground stations to receive and process Landsat imagery, which is used for a variety of purposes, including crop assessment, water-resource management, and mineral exploration. The United States plans to orbit a new Landsat satellite this summer, but has no definite commitment to continue service beyond its lifetime (1985).

France and Japan both plan to launch remote-sensing systems in the mid-1980s. The French SPOT will be operated on a commercial basis by a semi-private firm, Spotimage, which plans to sell advanced sensor data world-wide.

The Soviet Union has flown numerous short-term reconnaissance missions but has so far not made data broadly available. However, more recent Soviet systems could be used to provide information to other countries.

**Atmospheric remote sensing for meteorology** - Satellite imagery and other satellite-derived data are a major source of vital weather information, especially in developing countries. The U.S. maintains two sets of civilian meteorological satellites, the polar orbit NOAAs, and the geosynchronous GOES satellites. Information from them is distributed globally.

Other countries also have weather satellites, notably the Soviet Union and Japan. International agreements on open and free exchange of meteorological information are well-established; and efforts have been made to coordinate national programs for predictive and research purposes, largely through the World Meteorological Organization (WMO), a specialized U.N. agency.

## 3. Cooperation, Competition and the International Regime for Space Activities

Cooperation and competition with other countries, along with participation in international organization all play a central role in U.S. space policy. On the one hand the nations that have acquired access to space represent a commercial challenge to U.S. aerospace and satellite communication firms, as well as a political challenge to U.S. leadership. On the other hand, cooperation with other space-capable countries can reduce the costs of developing expensive new technologies, give the United States access to foreign markets, and aid foreign policy objectives.

Since outer space belongs to no one nation, but is understood to be an international commons akin to the high seas, the use of space by any state necessarily involves the international community. Because traditional international legal principles were based chiefly on the rights and powers of territorial sovereignty, they are often in conflict with the most efficient use of new space systems. It has therefore been in the interest of the United States and other nations to work together to develop an international legal regime for outer space. Several international organizations already exist to develop legal principles and to coordinate the uses of outer space.* Figure 1 illustrates the international organizations involved in space.

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*For a summary discussion of the organizations most concerned with developing these legal principles and the body of international law that they have produced, see the OTA report, Civilian Space Policy and Applications, Appendix F, The International Legal Regime of Outer Space.

Patterns of Global Outer Space Activities

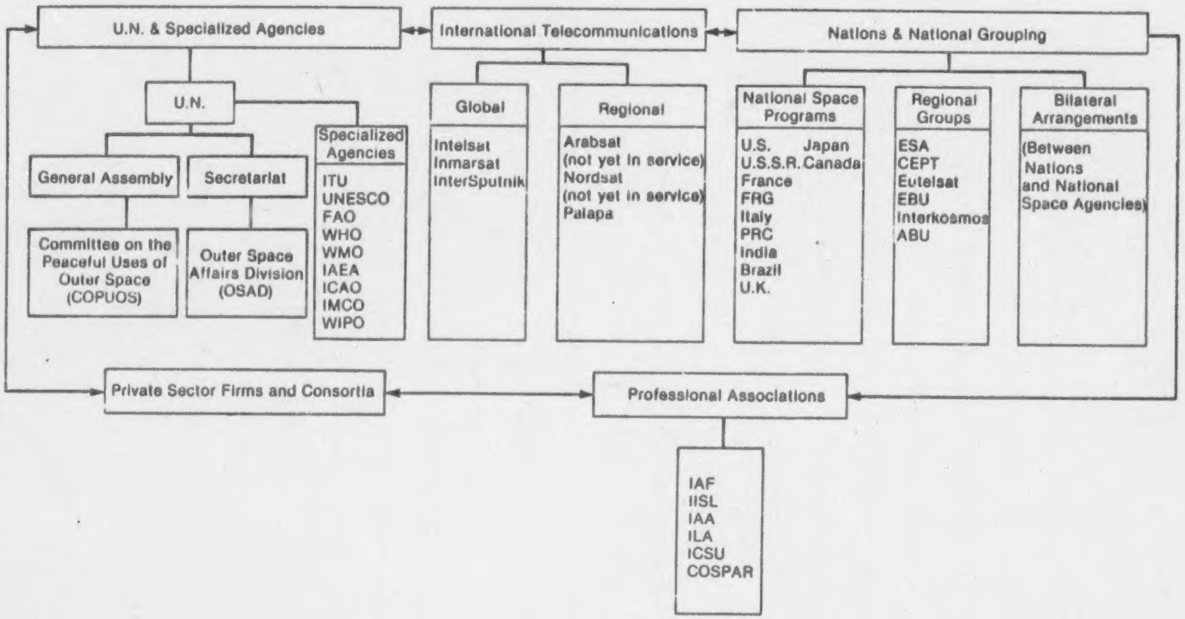

U.N. & Specialized Agencies
International Telecommunications
Nations & National Grouping
U.N.
General Assembly
Secretariat
Specialized Agencies
ITU
UNESCO
FAO
WHO
WMO
IAEA
ICAO
IMCO
WIPO
Committee on the Peaceful Uses of Outer Space (COPUOS)
Outer Space Affairs Division (OSAD)
Global
Intelsat
Inmarsat
InterSputnik
Regional
Arabsat (not yet in service)
Nordsat (not yet in service)
Palapa
National Space Programs
U.S.
U.S.S.R.
France
FRG
Italy
PRC
India
Brazil
U.K.
Japan
Canada
Regional Groups
ESA
CEPT
Eutelsat
EBU
Interkosmos
ABU
Bilateral Arrangements
(Between Nations and National Space Agencies)
Private Sector Firms and Consortia
Professional Associations
IAF
IISL
IAA
ILA
ICSU
COSPAR

Figure 1

## Cooperation

International cooperation has been a central element of the U.S. civilian space program since its inception. The National Aeronautics and Space Act of 1958, the law that initiated this nation's civilian space program, says that space activities should "be devoted to peaceful purposes for the benefit of all mankind," and that the U.S. will engage in "cooperation...with other nations and groups of nations." The U.S. program, unlike that of the Soviet Union, has been openly conducted, with both successes and failures publicly presented.

The United States has engaged in hundreds of bilateral and multilateral cooperative ventures in every area of space technology. U.S. launchers have orbited complete satellites and instrument payloads for dozens of countries. The United States took the lead in 1963 in establishing Intelsat and providing satellite communications around the world. Its meteorological satellites have been used for global weather coverage since the early 1960s, and the Landsat earth remote-sensing system has been in operation since 1972 under a policy whereby the U.S. has sold imagery to any country for little more than the price of reproduction. NASA and the Agency for International Development have cooperated in giving developing countries valuable training in the use of Landsat data, as well as in using satellite communications to deliver programs to rural areas. The ATS series of experimental direct-broadcast satellites was used in the mid-1970s to carry out several important studies in India and South America.

More recently the United States has engaged in a major cooperative project with the European Space Agency (ESA) and Canada to develop the Space

Transportation System (STS). In return for access to the Space Shuttle, ESA has produced Spacelab and the Canadians the Shuttle Remote Manipulator, an essential component of the shuttle's ability to release and retrieve satellites in orbit.

In manned spaceflight, the United States and the Soviet Union cooperated in several projects during the 1970s, culminating in the 1975 Apollo-Soyuz Test Project (ASTP). In one of the most dramatic symbols of detente, a U.S. Apollo spacecraft docked in orbit with a Soviet Soyuz.

Not all U.S. cooperative ventures have been entirely successful, however. In the early 1970s the United States made a proposal to the Europeans for the development of a Space Tug; it was later withdrawn for economic and political reasons. In particular, the Air Force did not want the United States to depend on a foreign consortium for an essential part of the STS. Another difficult venture was the International Solar Polar Mission (ISPM), a dual-spacecraft scientific project being conducted jointly with ESA. For budgetary reasons, the United States withdrew its satellite from the mission in 1981. These setbacks have made some European countries highly sceptical of the U.S. ability to stick to long-term commitments. Cooperation with the Soviet Union has been subject to the ups and downs of East-West relations, and most cooperative projects have recently been cancelled.

## Competition

Competition with other countries, notably the Soviet Union, has been a central component of U.S. policy. The NAS Act calls for "the preservation of the role of the United States as a leader in aeronautical and space science and the applications thereof." During the late 1950s and throughout the

1960s, the United States attempted to match and surpass the Soviet Union, particularly in manned spaceflight. Following the U.S. success in landing the first men on the moon in 1969, this sense of rivalry abated considerably, at least for civilian spaceflight. Both the United States and the Soviet Union have, however, maintained an increasing level of military space activities that are in large part motivated by the need to balance and counter their respective adversaries. In recent years U.S. preeminence in space has been threatened by advanced space systems being developed in Europe and Japan.

Until recently, the United States benefited economically and politically from the development of space programs in other nations because these nations constituted a growing market for U.S. goods and services. However, even though the overall market is increasing, countries with developed space programs compete with us in selling satellite communications systems and components, remote sensing data, and launching services to foreign and domestic users. By maintaining an active and aggressive posture in international fora, the Government can aid the U.S. private sector in maintaining or expanding its position in these high technology markets.

## The International Regime for Outer Space

Broadly speaking, international regulation and coordination of states' activities serves to protect common interests and to ensure that special interests are dealt with in a common framework. Given the ever larger percentage of nations that use and/or produce space technology, the United States is increasingly affected by actions taken in other nations and in international forums. Thus it is as important for the United States to participate in negotiations and discussions concerning space activities as it is for other nations. With more countries making greater use of space technology, however, it has become more and more difficult to agree on international legal principles affecting commercial and political uses of space technologies. There is both an increasing dependence by developed and developing countries on space technologies, as well as a marked increase in political activity by developing countries in international organizations, especially the United Nations. The whole range of so-called 'North-South' issues, including the demands made by many developing countries for a New World Economic Order and, more recently, a New World Information Order, have deeply affected discussions of outer space affairs at the United Nations and elsewhere.

The United States is a member of the following international organizations' for ordering and regulating the use of space:

**United Nations Committee on the Peaceful uses of Outer Space (COPUOS).** COPUOS is the primary locus for the discussion of legal principles concerning outer space and development of space treaties. COPUOS was established in 1959 with an initial membership of 24 countries, which was expanded to 28 in 1961, 37 in 1973, and 53 today (see figure 2). Within COPUOS decisions are made by consensus among all the members, rather than by majority vote. COPUOS is serviced by the U.N. Outer Space Affairs Division, which is part of the U.N. Secretariat and has a small permanent staff (see figure 3). The legal subcommittee of COPUOS has formulated five major treaties, for many of which the U.S. played a leading drafting and negotiating role.

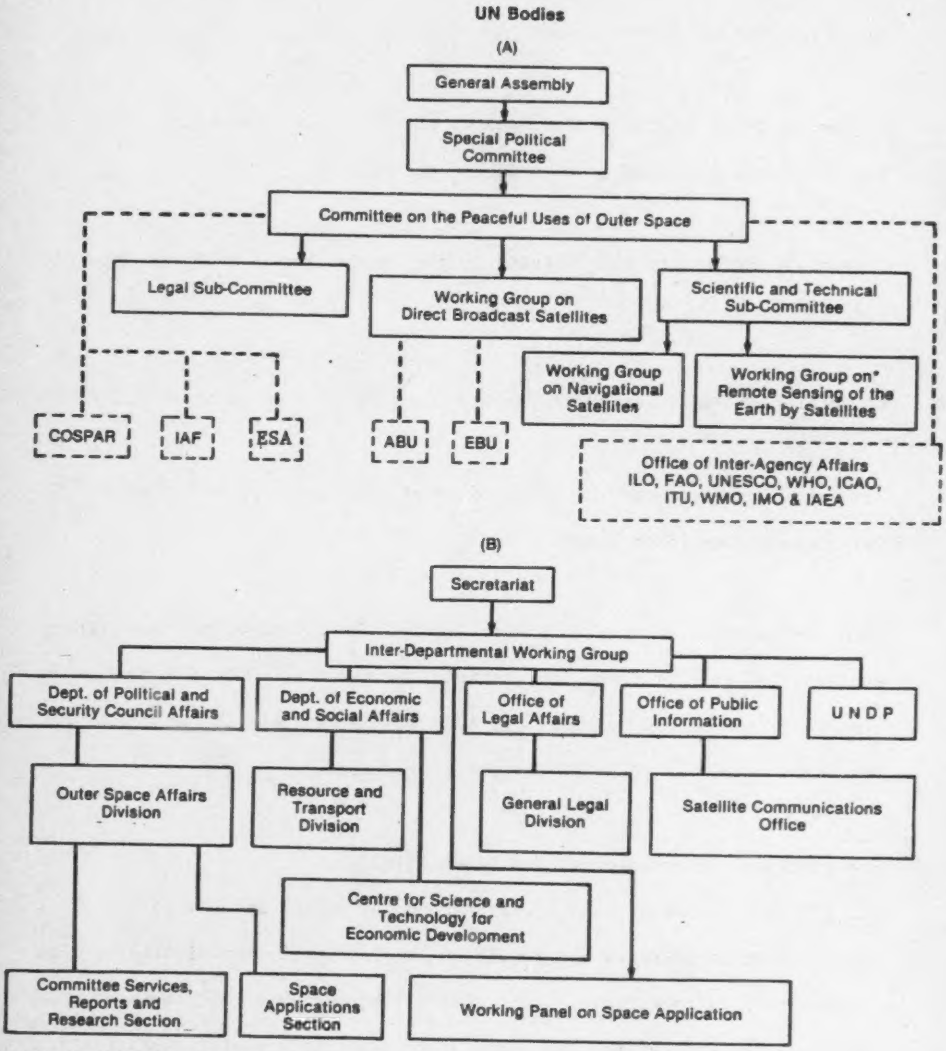
o Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other

**CURRENT MEMBERSHIP OF COPUOS**

| Developed Western Countries | Soviet Bloc | Developing Countries | Independent |
|---|---|---|---|
| Australia | Bulgaria | Argentina | Albania |
| Austria | Czechoslavakia | Benin | China* |
| Belgium | German Democratic Republic | Brazil | Yugoslavia |
| Canada | Hungary | Chad | |
| Federal Republic of Germany | Poland | Chile | |
| France* | Romania | Columbia | |
| Greece | USSR* | Ecuador | |
| Italy | Vietnam | Egypt | |
| Japan* | | India* | |
| Netherlands | | Indonesia | |
| Spain | | Iran | |
| Sweden | | Iraq | |
| United Kingdom | | Kenya | |
| United States* | | Lebanon | |
| | | Mexico | |
| | | Morocco | |
| | | Niger | |
| | | Nigeria | |
| | | Pakistan | |
| | | Philippines | |
| | | Sierra Leone | |
| | | Sudan | |
| | | Syria | |
| | | United Republic of Cameroon | |
| | | Upper Volta | |
| | | Uraguay | |
| | | Venezuela | |

Underscoring indicates COPUOS membership 1961-1973
Asterisk indicates independent launch capability

Figure 2


UN Bodies
(A)
General Assembly
Special Political Committee
Committee on the Peaceful Uses of Outer Space
Legal Sub-Committee
Working Group on Direct Broadcast Satellites
Scientific and Technical Sub-Committee
Working Group on Navigational Satellites
Working Group on* Remote Sensing of the Earth by Satellites
COSPAR
IAF
ESA
ABU
EBU
Office of Inter-Agency Affairs ILO, FAO, UNESCO, WHO, ICAO, ITU, WMO, IMO & IAEA
(B)
Secretariat
Inter-Departmental Working Group
Dept. of Political and Security Council Affairs
Dept. of Economic and Social Affairs
Office of Legal Affairs
Office of Public Information
U N D P
Outer Space Affairs Division
Resource and Transport Division
General Legal Division
Satellite Communications Office
Centre for Science and Technology for Economic Development
Committee Services, Reports and Research Section
Space Applications Section
Working Panel on Space Application

*Accomplished its original mandate in 1974 but can be recalled at any time by the parent Committee.

NOTE: Broken lines represent observers.

Figure 3

Celestial Bodies (1967)

- Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968)
- Convention on International Liability for Damage Caused by Space Objects (1972)
- Convention on Registration of Objects Launched into Outer Space (1974)
- Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Treaty) (1979)

With the exception of the 1979 Moon Treaty, the United States has signed and ratified each of these international agreements. COPUOS served as the preparatory committee for UNISPACE '82 and has been the major forum for debate over the UNISPACE Conference report.

**International Telecommunications Union (ITU)**

The ITU is an international intergovernmental organization with 155 members that coordinates and regulates international communications. Its primary task is to allocate and register frequencies on the basis of technical considerations. In addition to allocating radiofrequencies for terrestrial communications, it also coordinates the disposition of space frequencies and the positioning of satellites in geostationary orbit. The ITU coordinates use of the electromagnetic spectrum by assigning parts of the spectrum to particular types of users (e.g. to radio astronomy) rather than by deciding on specific requests for frequencies. This is done largely through periodic World and Regional Administrative Radio Conferences (WARCs and RARCs). The last WARC was held in 1979 and was the occasion for considerable conflict between the U.S. and developing countries over frequency allocations and the placement of satellites in geosynchronous orbit.

Upcoming ITU conferences include a Plenipotentiary in September 1982, at which the internal organization of the ITU will be discussed and amended; and a Western Hemisphere RARC in June 1983, which will be critical for allocating U.S. direct-broadcast satellites. Both meetings could be strongly affected by recommendations made at UNISPACE '82.

## Other U.N. Agencies

### United Nations Educational, Scientific and Cultural Organization (UNESCO)

UNESCO is neither a regulatory agency such as the ITU, nor does it have a broad interest in space matters like COPUOS. However, as the UN agency most concerned with scientific and cultural issues, including the use of communications for third world development, it necessarily has an interest in these matters as they relate to the use of space systems. UNESCO is also the focal point for discussions of the New World Information Order and related issues.

In 1972 UNESCO adopted a "Declaration of Guiding Principles on the Use of Satellite Broadcasting for the Free Flow of Information, the Spread of Education and Greater Cultural Exchange." Strong objections have been voiced against this declaration by the United States and other nations on the grounds that instead of encouraging the free-flow of information, it encourages censorship. The International Programme for the Development of Communication (IPDC) was established in 1980, to continue efforts in this area, including an experimental project (with assistance from Intelsat) for the encouragement of third-world broadcasting.

UNESCO has worked with many African, Asian, and Latin American states, helping them to assess their general communication needs. UNESCO is presently conducting several long-range studies to determine the practicality of using regional satellite systems to supply educational and cultural development programs to developing countries. UNESCO is also active in programs to use satellite remote-sensing data to monitor the environment and natural resources.

**World Meteorological Organization (WMO)** - WMO organizes and coordinates global weather and climate studies such as World Weather Watch (WWW) and the Global Atmospheric Research Project (GARP). Virtually all of WMO's work involves the use of satellite information.

**Food and Agricultural Organization (FAO)** - The FAO has established a remote-sensing centre to monitor renewable resources, using Landsat imagery to support field services. FAO has an extensive library of Landsat data as well as a laboratory for interpreting aerial and satellite images.

**United Nations Development Programme (UNDP)** - UNDP funds a variety of development projects, including training courses and regional centers for broadcasting and resource management. An experimental satellite prototype communication earth station suited for low-cost mass production is among its current programs.

## 4. Political Context of UNISPACE '82

Ostensibly, UNISPACE '82 is a scientific and technical meeting to discuss the practical uses of space technology, especially in developing countries. The United States has expressed its hope that controversial political questions can be kept off the agenda, and that the majority of the delegates will be specialists equipped to discuss scientific and technical issues. However, the history of previous U.N. conferences and of COPUOS strongly suggests that most participating countries see UNISPACE '82 as a political arena, and that the majority of the delegates will have political rather than scientific or technical backgrounds. This high degree of 'politicization' at UNISPACE '82 means that outside issues - i.e. political, economic, and military issues not directly related to space technology and its uses - may well affect positions taken at the Conference.

The political context of UNISPACE '82 has two main components: a long-standing East-West rivalry that goes back to the beginning of the space age, and a more recent set of North-South issues that are associated with comprehensive international proposals for restructuring relations between developed and developing countries, such as the New World Economic Order and the New International Information Order. In addition, political crises in the Falklands, the Mid-East, and elsewhere may strongly affect the Conference atmosphere as well as the alignment of regional and political blocs. Before examining the particular issues of UNISPACE '82, the following section will outline the general political context within which UNISPACE '82 will take place.

**General Context:** As is the case for the majority of issues dealt with by the United Nations, the dominant political division at UNISPACE '82 will be between developed and developing countries. In general, the developing countries will seek to gain greater access to and control over advanced space technologies which have been developed by the industrialized nations. They are likely to do this by advocating legal and regulatory regimes for various space activities in which broadbased international organizations, where developing countries outnumber and can outvote developed ones, can play a decisive role. They are also likely to promote multilaterally funded and controlled bodies to transfer know-how and technology to the developing world.

To a great extent third world initiatives in space affairs stem from and draw upon broader initiatives and concepts, e.g.the Law of the Sea Treaty, that have gained widespread acceptance and support from developing countries over the past decade. These include:

- **The New World Economic Order (NWEO)** - In its specific form, the New World Economic Order had its inception at the United Nations in 1974, when the General Assembly approved the Charter of Economic Rights and Duties of States. Championed by the non-aligned nations (organized into the so-called "Group of 77"), the Charter was animated by the perception that economic relations between developed and developing countries were inequitable and should be changed by fundamental alterations in the structure of global economic affairs. These alterations would be designed to transfer wealth, expertise, and above all political power from the "haves" (the industrialized West or "North") to the "have-nots" (the less-developed countries or "South"). The negotiations over the Law of the Seas Treaty constitute an excellent example of this thrust by the developing world.

The specific provisions of the Charter, many of which dealt with the terms of trade (tariff and non-tariff barriers, commodity price-stabilization, etc.) between North and South, have been debated vigorously in a host of fora, particularly the U.N. Conference on Trade and Development (UNCTAD). Through these discussions, and through the Group of 77's success in organizing and voting as a bloc, the developing countries have largely succeeded in setting the terms of the debate on North-South relations, both by putting the North on the moral defensive, and by otherwise legitimating demands in a multitude of areas for the transfer of wealth and power to the South. A particularly important consequence has been the politicization of economic discussions, with developing countries claiming a right to an equal share of the world's economic and technical pie, and the North responding that any assistance is not a matter of right or of compensation for past injustice, but a freely proffered gift. In addition, a large part of the South's effort has gone towards restricting the activities of foreign private corporations in developing countries; New Economic Order positions favor state control of internal economic affairs and direct state-to-state agreements that give political authorities greater control over international trade. There is a marked preference, too, for comprehensive multilateral transfer programs rather than more traditional bilateral aid projects.

The position of the Soviet Union and other developed communist countries in these debates has varied. The Soviet Union has taken the position that since it was never a colonial power, it has no corresponding duty to make redress by contributing to North-South transfers. Though largely successful in dissasociating themselves from the West, the Soviets have on occasion been lumped together with the North, and therefore sometimes (usually as tacitly as possible) side with the West in opposing transfer proposals. China, on the other hand, initially stood aloof from the non-aligned movement and the New Economic Order, but as it has come to participate more in the United Nations and other international organizations, has associated itself increasingly with the South.

It should be emphasized that neither the North nor the South maintain unanimity on issues under dispute. Though the Group of 77 has been particularly successful in articulating common positions and organizing bloc votes, developing countries are split along political, regional, and economic lines. Agreement on general issues does not always carry over to specific proposals. Within the West, disagreements on both generalities and specifics are more widespread, with voting en bloc a rarity. Countries like the United States that have a strong preference for a relatively unrestricted private sector are frequently at odds with others, such as Sweden, who favor state-oriented programs and are more sympathetic with the South.

In the case of space activities several specific differences affect the context of discussions. First, the U.S. and Soviet Union have clearly been the dominant forces and are hence lumped together more often here than in other areas. Second, the role of technology (as opposed to other sorts of economic and political mechanisms) is central, and hence the demands for technical expertise and subsidized use of operational systems are greater. Developing countries have recently begun to place greater emphasis on access to technology, including space technology, claiming that without technical expertise they will be relegated to permanent economic inferiority. The 1979 U.N. Conference on Science and Technology for Development (UNCSTD) helped to crystallize these sentiments by pointing to the unequal distribution of technology as a primary factor in the dependent position of developing countries, and calling for a major effort to transfer technology from North to South. UNCSTD served as an explicit starting point for UNISPACE '82 (see para. 8 of the Draft Report).

- **The New World Information Order (NWIO)** - In many ways similar to the New World Economic Order, the proposals for a New World Information Order stem from the claim by developing countries that a) they do not have equal access either to relevant information or to the technologies needed to acquire and disseminate it, and are hence at a disadvantage in economic and political dealings with the North, b) news coverage of their countries is both sparse and slanted, due to the cultural and political biases of Western reporters, and c) Western media bring about cultural and economic disruption in developing countries by raising expectations and popularizing alien perceptions.

There have been a multitude of proposals associated with NWIO, mostly involving increased state control over what foreign journalists would be allowed to report abroad, and what the state is obligated to tell its own citizens. Licensing of journalists, detailed rules for reporters, and required "equal time" for official views, have been among the proposals. In general, NWIO supporters object to private organizations and individuals from the West being allowed to investigate and report freely on conditions in developing countries, particularly when their results are made available domestically via international broadcasts, wire services, and newspapers. Because of the support that NWIO gives to government controls over information, it has been enthusiastically supported by the Soviet Union and other communist countries. The United States and most Western states have been strongly opposed to prior restrictions on the content of international news coverage, and have invoked the U.N. Charter's guarantee of unrestricted access to information.

The means of communication are also at issue. On the one hand, developing countries point to their lack of communications infrastructure as a key cause of information inequities. On the other, they see advanced Western technologies, such as communications satellites, as posing an even-greater threat to their sovereignty. Hence, they have demanded aid in acquiring communication systems, and have proposed to regulate or restrict the use of technologies such as direct-broadcast and land remote-sensing satellites. UNESCO, for instance, is engaged in drawing up a "Declaration of Guiding Principles on the Use of Satellite Broadcasting for the Free Flow of Information, the Spread of Education and Greater Cultural Exchange." Developing countries have also proposed establishing multinational satellite systems through the United Nations that would give them greater control over and access to advanced technologies. The most authoritative expression of NWIO proposals, the UNESCO commissioned study Many Voices, One World (or MacBride report), which was completed in 1980, endorses efforts at the ITU to allocate geostationary slots on a more equitable basis.

It is important to note that "information" includes not only traditional voice, print, and video but also computer data and satellite remote-sensing imagery. The regulation of the international movement of information, in all its forms, would therefore affect not simply political news coverage but also resource and financial management by governments and multinational firms.

- **Common Heritage** - An idea with particular relevance to space activities is the notion of "Common Heritage." Common Heritage was first proposed in 1967 by Arvid Parto of Malta at the U.N. during discussion of the proposed negotiations on the Law of the Sea. Subsequently it became an integral part of the draft Law of the Sea treaty as well as the draft Agreement Governing the Activities of States on the Moon and other Celestial Bodies (the so-called "Moon Treaty"), which was negotiated in the Legal Subcommitee of COPUOS during the 1970s.

Common Heritage is generally applied to areas such as the deep seabed, outer space, and Antarctica, that are not sovereign part of any one nation. Such areas were initially understood to be open to transit and exploitation by any nation, without being subject to permanent appropriation. However, under the influence of the New World Economic Order, Common Heritage came to be interpreted by developing nations as calling for a more active jurisdiction over such areas by multinational bodies designed to regulate activities and allocate resources. In the case of the Law of the Sea, a Seabed Authority was devised with power to define the terms under which private companies could mine ocean minerals, and with a specific mandate to transfer ocean mining technology and a portion of the revenues from ocean mining to developing countries. For the Moon Treaty, a somewhat similar body was envisioned to regulate future ventures on the Moon and planets. In both cases the proposals were justified on equity grounds as ways of allowing developing countries to share in the exploitation of resources that belonged to all but were accessible only to advanced industrialized countries.

Though the United States initially supported Common Heritage, it eventually came to oppose both the Law of the Sea and the Moon Treaty as more radical interpretations gained the ascendancy. Although the Soviet Union and other developed states were also in opposition, the U.S. was more vocal and ended up receiving much of the blame for blocking a consensus agreement, especially at the Law of the Sea negotiations. Though not explicitly invoked, the Common Heritage concept has played an important role in shaping discussions about the allocation of other common resources, particularly the geosynchronous orbit and the electromagnetic spectrum, which have been debated at the ITU and will be on the agenda at UNISPACE '82. U.S. refusal to sign the Moon Treaty, and its more recent refusal to sign the Law of the Sea (the United States was one of only four countries to vote against it) will strongly affect perceptions of the United States at UNISPACE '82.

**Particular Context** - Recent and ongoing political disputes will likely have a strong effect on UNISPACE '82 delegations, particularly on the degree of support the United States can expect for its interests. It should be remembered that for many developing countries that lack direct interest in outer space affairs, positions likely to be taken at UNISPACE will be a function of outside political concerns rather than of the particular issue itself. Many such countries will vote as members of regional or economic blocs. For instance, the recent dispute in the Falklands may cost the United States the support of a number of Latin American countries that have traditionally stood with us at COPUOS. The current Middle East crisis may have the same effect on certain Arab states. At the least the United States can expect that support from these countries will be more difficult to obtain and will come at a higher price, perhaps requiring trade-offs on non-space issues.

## 5. Controversial Issues at UNISPACE '82

Many of the most crucial issues did not originate with UNISPACE '82. Most of them have been raised, discussed and argued since the very beginning of the space age twenty-five years ago. The annals of the United Nations that deal with the formation of COPUOS and the Outer Space Affairs Division provide ample proof that with regard to the politics of space technology, there is little new under the sun. The limits of outer space, the broadcast and surveillance rights of space powers, the needs of developing nations and the concern over the militarization of space can all be found in the early UN reports and country papers. What has changed most dramatically is the political context of the discussions (as outlined in Section 4); the state of space technology itself; and the expanded number of states having access to or otherwise relying on that technology. The recent experience at COPUOS, where the draft Conference Report was discussed and amended (March/April 1982), is a case in point.

Conference decisions will be based on the output of the deliberations of three main committees that will be presented to the conference for adoption in plenary session. At UNISPACE, disputed issues can, with an initial 2/3 agreement, be put to a vote of the entire membership. These committees reflect the major divisions of the draft conference report:

1. State of space science and technology
2. Applications of space science and technology
3. International cooperation and the role of the United Nations

The issues that are likely to be in dispute at the conference cut across these broad subject areas.

The debate at UNISPACE '82 will be shaped in large part by the draft Conference Report, a 116 page document prepared by the UNISPACE '82 secretariat led by Dr. Yash Pal of India. Although the draft Conference Report and UNISPACE '82 itself present the occasion for discussing the points of contention between nations over space technology, it seems unlikely to resolve them. On the surface, the nations who participated in the COPUOS deliberations accomplished a great deal in agreeing to the wording of 415 out of 428 paragraphs of the draft conference report. Many paragraphs containing crucial issues were amended to reflect the wishes of one or another state and agreed to by consensus, the normal means of reaching agreement within COPUOS. However, this success is somewhat deceptive since some of the changes in wording tended to "paper over" real issues for the sake of arriving at consensus. In many instances, the issues were not resolved, merely skirted. Paragraphs that did not gain consensus were included in the final draft along with suggested alternatives in brackets.

The main issues that will be debated at UNISPACE '82 can be divided into "old" issues, that is, problems that have been extensively debated at COPUOS and elsewhere without as yet gaining consensus; and "new" issues that are peculiar to UNISPACE '82 or have recently come to fore. This section will outline the issues, with references to the Conference Report.

## "Old" Issues

### o Geostationary Orbit

Of all the possible orbits satellites can take around the Earth, the geostationary orbit (GSO) is both most useful and most restricted. This orbit is a narrow band in the equatorial plane of the earth. Objects in geostationary orbit remain fixed with respect to points on the earth's surface. Almost all present and projected civilian communications satellites and some meteorological satellites are located there; already, certain portions of the geostationary arc are becoming congested electromagnetically (satellites broadcasting on the same frequencies need to be kept far enough apart so as not to interfere with one another). Physical congestion of the GSO is also of concern because the probability of collisions between working GSO satellites whose positions are highly controlled and uncontrolled obsolete satellites grows each year. The value and scarcity of the geostationary orbit have given rise to two separate disputes.

**a) allocation of orbital slots and frequencies:** The responsibility for preventing both physical and electromagnetic interference now rests with the ITU, which reviews all planned satellite launches. The ITU grants satellite slots on a first-come first-served basis; any country or organization that desires a satellite and can place it in orbit can do so, provided it doesn't interfere with other satellites. This position is supported by the United States and other developed states, who argue that this allows for the most efficient use of the orbit. However, many developing states have objected that first-come first-served may mean that the orbit will be "used up" by developed countries before developing countries and regions can place their own satellites in orbit. Developing countries argue that the geostationary orbit is a "limited resource" and, as such, should be deliberately allocated (perhaps on a country- by -country basis), even if some countries cannot currently make use of their orbital slots. Some also object that many satellites are used for entertainment or other less -than -vital purposes, and that developing countries should have priority in using satellites for basic communications. Paragraph 284 of the draft report says "...it may become necessary for each country or international organization to examine whether all the satellites it is operating are really required...these systems use increasing amounts of a limited resource that is for use by all States."

The U.S. position has been that GSO is not truly a "limited resource" since technical advances can expand its use as far as is needed. Already the required orbital spacing for 6/4 GHz (the most widely used commercial frequency) satellites has decreased from 5° to 3°, and recent advances, including the use of higher frequencies (14/12 and eventually 30/20 GHz) are likely to enlarge greatly the potential communications traffic. The United States and other Western states strongly object to any multilateral a priori allocation of slots or frequencies. They see any comprehensive plan for geostationary allocation as restrictive and inflexible, and likely to give developing countries a veto over new satellite deployments and to impede technical development. In the draft report the United States argued for language emphasizing the development of new technologies (see para. 281). The United States also supported giving the existing ITU structure responsibility for GSO allocations, rather than relegating that task to other entities (see para. 284, where the original phrase "with the help of ITU" was changed to "within the ITU").

Developing countries object that while new technologies can expand the GSO's potential, they are also more expensive, both for the space and ground segments, than current 6/4 GHz systems. In a controversial paragraph, the draft report says "...it seems desirable that developed countries shift their satellite communication system to a different frequency band (e.g. 11/14 GHz), leaving the 6/4 GHz band basically for use by developing countries. Developed countries should also be encouraged to shift their high-density and transoceanic traffic to submarine cable or fibre-optic systems, thereby decreasing the pressure on the radio frequency spectrum and on the GSO." (para. 150).

Conflicts over satellite allocations exist between developed countries as well. For example, the United States and Canada dispute about spacing and interference for national satellites, with Canada charging that U.S. systems threaten to displace domestic ones. Partly as a consequence, the United States cannot count on Canadian support for its first-come first-served position, either at UNISPACE '82 or in the ITU.

b) **Ownership of GSO** - The importance of GSO, the unsettled status of the longstanding dispute in COPUOS over where airspace ends and outer space begins, and the desire of certain developing countries to exert greater leverage in the international system, have led to a controversy over the ownership of the GSO. In 1976, seven equatorial states, including Colombia, Ecuador, and Indonesia, issued the Bogota Declaration claiming sovereignty over the portion of the geostationary arc above their respective territories. Since the 1967 Outer Space Treaty explicitly rejects sovereign claims to outer space, the Bogota signatories argued that GSO was not in fact part of outer space but a distinct region determined by the earth's gravitational pull. Since an exact definition of "outer space" has never been agreed to - the Soviets have proposed 100 kilometers, while the United States has argued that any such definition is arbitrary and unnecessary - the Bogota claims are not in explicit disagreement with international law. However, all authorities have held that GSO is indisputably part of outer space, and both the United States and the Soviet Union have rejected the equatorial claims.

Support for this position by other developing countries has been mixed, partly because ownership by any one nation contradicts the common heritage principles underlying developing country requests for access to GSO. In the conference report the equatorial claims are mentioned without being supported (see para. 281). Despite this lack of support, several equatorial states, particularly Colombia, have steadfastly and vociferously presented their case, and are likely to do so again at UNISPACE '82. Even if they lose their main argument, they may try to gain sufficient support to extract concessions on access to GSO or other issues.

- **Remote-Sensing**

Since the first use of military remote-sensing satellites by the United States and Soviet Union in the early 1960s, some states have raised questions about the right of a country to acquire images of other countries, and the right to disseminate such data to third parties. Essentially, both the United

States and the Soviet Union agreed not to object to such activities, provided information was not publicized or shared with other than close allies. When the U.S. civilian Landsat satellites began operation in 1972, economic issues arose regarding distribution of data on mineral and other resources, and access to national data by foreign governments and private companies. The U.S. policy of public dissemination enabled all parties to have equal access to information; in addition, the United States provided developing countries with assistance to enable them to use Landsat data for national purposes. Today, since many of these countries use Landsat data on a regular basis, and a new commercially-oriented system (French SPOT) is about to be flown, the political and economic questions concerning resolution limits, prior consent, pricing policies and data discrimination and distribution have taken on new urgency.

The new civilian systems will provide resolutions of 30 meters (U.S. Landsat) down to 10 meters (SPOT); such systems can not only yield information regarding natural resources but also data on some military and other security-related items. Many countries favor either restrictions on the resolution of satellite sensors, or a legal regime requiring the permission of sensed countries before data is obtained. Countries particularly object to such data being released or sold publicly, especially if this is done before the data is available to the sensed country. They argue that countries not only have sovereignty over their natural resources, as provided in international law, but also over information about these resources. In the Legal Subcommittee of COPUOS, the Soviet Union has proposed restrictions on dissemination of data with better than 50m resolution.

The United States has objected to resolution limits and also to prior restrictions on obtaining and disseminating data. It sees any regime that controls information on resources as incompatible with the free flow of international information. In addition, such regulations might affect sensitive military operations. The United States favors the most open possible regime both for obtaining and disseminating remotely sensed data.

It is important to note that the political difficulties associated with remote sensing were not raised in the draft Conference Report. Instead, perhaps because these issues are being discussed at the Legal Subcommittee of COPUOS, the report emphasizes the economic implications of remote sensing and raises special concern for continued access to data from remote-sensing systems and the efficient coordination of the various existing and new systems for use by developing countries (see para. 163-172 and 265-272). At present, developing countries are more concerned with maintaining and increasing the practical uses of remote sensing than with potential political difficulties.

In the case of the Landsat system, the report expresses concern about its future continuity, given the large investments made by many developing countries in the system. As the only civilian satellite system that produces land remote sensing data, the U.S. Landsat system is looked to by both domestic and foreign users to supply needed data for resource management and exploitation. Countries that have invested in Landsat receiving stations and/or extensive processing hardware and software are anxious to have a continuing supply of MSS data to continue their work. The original draft report stated that such investments implied "an understanding or hope that data will continue to be available. Definite indications in this regard from satellite operators are necessary, so that countries can continue to invest in ground equipment..." (para. 87). At the March COPUOS Meeting the United

States succeeded in having "necessary" changed to "important"; the United States argued that the Landsat system was experimental and therefore the United States could not promise to continue it or to make data available on a heavily subsidized basis (see para. 94).

The concerns of developing countries are prompted by current domestic uncertainty over the status of the Landsat system. Price increases in the data, designed to recover a higher proportion of Landsat's operating cost, will go into effect October 1, 1982. The Administration is expected to state publicly that Landsat D', the follow-on to Landsat D, will not be flown, which will leave the operation of a civilian land remote sensing system after Landsat D fails entirely up to the French or the U.S. private sector.

The draft report encourages development of new and advanced sensors, such as active radar satellites to penetrate cloud cover, as well as higher resolutions (see para. 167). However, it also recognises that these systems are more expensive to build, operate, and use than simpler alternatives that may be more appropriate to developing country needs. Developing countries are concerned that advanced high-resolution systems with very high data-flow may place developing countries at a disadvantage and increase their dependence on industrialized countries.

- **Direct-Broadcasting by Satellite (DBS)**

As with satellite remote-sensing, developing countries see DBS as both a threat and a promise. DBS constitutes a potential threat because it allows foreign countries and private broadcasters to transmit programs directly to individuals, bypassing nationally controlled distribution systems; it also has much promise because DBS will allow countries to communicate internally without building expensive ground-based infrastructure. Therefore, many developing countries, strongly supported by the Soviets, want restrictions and regulations placed on the right to broadcast over national boundaries, while also encouraging the development of DBS systems for rural education, mobile communications, and other purposes. In particular, these countries want a legal requirement for prior consent before DBS broadcasts are made across national boundaries. The United States and other Western countries strongly oppose restrictions on the free flow of information. The legal subcommittee of COPUOS discussed DBS until 1981 without reaching agreement; in 1981 and 1982 COPUOS debated several draft texts, also without final result. After this impasse, some delegations threatened to take the issue to the General Assembly for a vote, bypassing COPUOS' consensus arrangement. Such an action is opposed by the United States because it would set a dangerous precedent for future COPUOS negotiations.

Once again, the disagreements on DBS are not simply North-South or even East-West conflicts. Within the developed West, Canada is concerned about the cultural impact of U.S. television programs that will become widely available with upcoming U.S. systems; Germany strongly objects to Radio Luxemburg's proposed commercial DBS television network. There is hence no consensus in the West about U.S. positions that favor minimal restrictions on DBS.

The establishment of a legal regime for DBS would vitally affect Western countries that will be competing to provide DBS systems to the rest of the world. Today, U.S., Canadian, European and Japanese firms all have this capability; adherence to a legal regime supported by Third World customers may be necessary to gain contracts abroad. Similar considerations apply to supplying remote-sensing data and services.

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In the draft conference report the political issues surrounding DBS are not raised, and emphasis is put on its potential for economic development. One way to finance expensive DBS satellites while exercising control over their use is to encourage an internationally-owned non-commercial satellite, perhaps through Intelsat; several such proposals are made in the draft report (see para. 249).

## "New" Issues

### o Militarization of Space

COPUOS and other international bodies have periodically debated military activities in space, chiefly related to nuclear weapons. The 1967 Outer Space Treaty prohibited weapons of mass destruction (primarily nuclear weapons) in outer space. In subsequent years there was relatively little discussion of military space systems; however, in 1981 key members of the Group of 77, including Brazil, Egypt, India, Nigeria, and Yugoslavia, expressed concern over "the growing dangers of the military uses of outer space." The Draft Conference Report contains four controversial paragraphs (para. 13, 205, 231, and 419) warning of these dangers, and the issue of militarization (or "weaponization") will in all probability be a major one at UNISPACE.

The underlying impetus to this issue is the increased use by both the U.S. and Soviet Union of space systems to support terrestrial military activities, and as well as the development of weapons designed to attack other satellites (anti-satellites or A-sats). The Soviet Union possesses a first-generation operational A-sat, and the U.S. has one under development; neither system, however, is based in space.

From 1977 to 1979 the United States and the Soviet Union conducted talks on limiting A-sat deployment; these were broken off following the Soviet invasion of Afghanistan. At these talks the Soviets expressed concern over the U.S. space shuttle, depicting it as an A-sat system. This worry about the shuttle surfaced again in August of 1981 when the U.S.S.R. proposed, at the General Assembly, a "Draft Treaty on the Prohibition of the Stationing of Weapons of Any Kind in Outer Space." Article 1 of the treaty prohibits stationing weapons in space (direct intercept A-sats launched from the ground without going into orbit would not be prohibited), including any "reuseable manned space vehicle," i.e. the shuttle. The Soviet proposal was referred not to COPUOS but to the U.N. Disarmament Committee, but it served to bring the issue of militarization to the fore.

In recent months a number of U.S. actions and statements have increased the perception that the United States intends to expand greatly its military space activities. These include:

- the release on July 4 of a White House Fact Sheet on National Space Policy with strong emphasis on national security programs. The fact sheet announced the formation of a new Senior Interagency Group on Space, chaired by the Assistant to the President for National Security Affairs.

- statements by the Secretary of Defense indicating that the United States is actively considering placing defensive weapons systems in space, along with highly publicized dicussions of directed-energy systems in Congress.

- establishing an Air Force Space Command to coordinate military programs.

- flying a classified DOD payload on the latest space shuttle mission.

The introduction of weapons into space, though not specifically prohibited by international law, raises strong emotions. From the inception of the space age, many have seen space as a "clean slate," an area from which earth-bound political and military rivalries could be excluded. Numerous declarations have extolled the peaceful uses of outer space. In part this may explain the strong language against militarization expressed in the draft conference report. The draft report does not point to specific difficulties but speaks generally of militarization as "a barrier to greater co-operation and a potential obstacle to deriving the full benefits of space technology," and of the impending "dark shadow over the peaceful and beneficial uses of space" (para. 13). The paragraph thus implies that emphasis on military space projects may divert resources and attention from developing countries. At the same time many nonaligned nations see this issue as a way to attack both the superpowers and to seize the moral "high ground" on a question with great potential international visibility.

The paragraphs dealing with militarization were subject to intense debate at the March COPUOS meetings, and no consensus on them was reached. The United States objected to the wording on three grounds: a) that COPUOS and UNISPACE were not the proper forum for this issue, which should be discussed in the Disarmament Committee b) that the discussion did not distinguish adequately between military satellites, such as communications and navigation systems, which are compatible with the peaceful uses of outer space, and actual space weapons, and c) that in any case the military uses of space would not interfere with peaceful uses or with the use of space systems by developing countries. Though the Soviet Union clearly intends to use the militarization issue in the future, it supported the U.S. objections to the draft conference paragraphs. Both countries rely heavily on space systems to support military operations, and to verify treaties on weapons deployment and neither wishes to engage in protracted multinational negotiations over highly sensitive issues best discussed, if at all, in bilateral meetings between the two space powers.

Though the U.S. was also generally supported by other Western countries, there is considerable sympathy for the demilitarization of space, particularly with respect to highly expensive future systems, such as directed-energy weapons, that may upset the strategic balance. There is also concern among U.S. allies that an expanded military role in space could hinder future civilian cooperative ventures, such as a possible joint space station; U.S. military participation in a space station would make European or Japanese collaboration politically difficult. For these reasons the United States cannot expect unanimous Western support at UNISPACE '82 for U.S. positions on this issue.

- **Transfer of Technology and the Role of the U.N. in Space Affairs**

If there is a single underlying theme to UNISPACE '82 it is the whys and wherefores of transferring space technology from developed to developing nations. The United Nations is seen as playing a crucial role in this process, partly because UNISPACE '82 is a U.N. Conference and has a particular mandate to make recommendations to the United Nations General Assembly. More importantly, however, the United Nations, as the largest and most prestigious international organization and the one dominated by developing countries, is the preferred agent of deliberation and execution for most activities related to the New World Economic Order and the New World Information Order. By contrast many developed countries, emphatically including the United States, see the United Nations as cumbersome and politicized, and hence inappropriate for carrying out actual transfer programs, even if such programs are desirable. In the preparations for UNISPACE '82 these opposing views have given rise to considerable disagreement on both the means and ends of technology transfer.

The basic justification for increased access to space technology is that it promotes development; many specific instances are cited in the Draft Report to support this view. However, the Report often assigns blame or responsibility to developed nations for the present state of affairs. This issue is raised early in the Draft Report by invoking the example of the 1979 U.N. Conference on Science and Technology for Development (UNCSTD), whose conclusions are said to be "in general, applicable to the field of space science and technology" (para. 8). Specific statements from the UNCSTD report are then cited. UNCSTD was a multinational conference similar to UNISPACE '82, that dealt with the whole range of technical issues. That conference was the occasion for numerous attacks on developed countries, which were accused of monopolizing science and technology; demands were made for large-scale transfers of technical capabilities to the developing world, and a U.N. Centre for Science and Technology for Development was established in Vienna to help accomplish the goals of the Conference. This Centre has so far been, in the view of the United States and other Western countries, a great disappointment, generating a good deal of anti-Western rhetoric but few concrete accomplishments, despite a $100 million annual budget. Western countries do not want UNISPACE '82 to be a replay of UNCSTD.

Among the UNCSTD conclusions quoted approvingly in the draft report are the claims that eliminating underdevelopment "presupposes an equitable distribution and creation of scientific and technological capabilities of the world," and that the "production and consumption patterns" of industrialized countries "have led to a waste of resources and often carried with them negative social and environmental consequences." (para. 8). An extension of these arguments is made in paragraph 11, where it is said that "Space technology can be a powerful tool to accelerate national development: it provides a way of leap-frogging over obsolete technologies and getting away from percolation and trickle-down models of development for which developing countries do not have the time... It is therefore necessary that all countries be able to have access to space technology." A bracketed sentence introduced by China explicitly blames developed countries: "In fact, only the developed countries with advanced technology can fully exploit these benefits. This state of uneveness is unfair and unreasonable. The international community should make common efforts to bring about a gradual change in the present situation. To this end, the developed countries with advanced technology, particularly the super space Powers, should assume greater responsibilities."

At the March COPUOS meeting, some developed countries objected both to the assignment of guilt (and the implied duty to make redress) for the uneven distribution of space technology, and to the exaggerated claims made for the ability of space technology to bring about development. They suggested language in paragraph 11 to the effect that "Space technology is by no means the complete solution to a country's problems" and, in paragraph 12, that "the future of developing countries depends primarily upon themselves... Space technology is not a magic wand that can bring sudden wealth." These suggestions were strongly opposed by many developing countries, most notably

**Nigeria.**

A related issue, particularly in the original versions of the draft report, was the emphasis put on self-reliance by developing countries; it urged developing countries to look to other developing nations for technical assistance in space related projects. Objections to this wording were made on the grounds that this was technically and politically unrealistic and that such urgings implied, incorrectly, that developing countries could not safely rely on cooperative projects with the West. (It should be noted that the draft report, especially in its early versions, strongly reflected the personal and national views of its principal author, Dr. Yash Pal of India; as the only developing country with an advanced civilian space program, India would benefit greatly from the promotion of such views). While supporting realistic efforts to develop indigenous scientific and technical capabilities, the United States does not want to encourage a "go-it-alone" mentality motivated primarily by distrust of developed countries.

o **The Proposed U.N. Centre for Outer Space Affairs**

In the course of the preparations for UNISPACE '82, numerous new and expanded responsibilities for the U.N. itself have been debated. In the original version of the draft report, these coalesced into a proposal to establish a U.N. Centre for Outer Space Affairs, which would conduct extensive studies, provide technical assistance to developing countries, and disseminate information. The Centre was to be independent of (and in large part would supplant) the current U.N. Outer Space Affairs Division (OSAD) and to have its own staff and budget, both substantially larger than under present arrangements.

This proposal ran into considerable opposition from several quarters. Within the United Nations, the center was seen as encroaching on activities already performed by a number of independent U.N. agencies, including World Meteorological Organization (WMO), U.N. Development Programme (UNDP) and the U.N. Centre for Science and Technology. Many countries, including the United States, objected to the considerable added expense. And the Soviet Union was opposed to any diminishment of the powers of OSAD, given their dominant position in the Committee on Political and Security Council Affairs which oversees the Division.

The second draft, therefore, contained increased emphasis on coordinating activities with other U.N. agencies. However, the report still claimed that "financial resources will need to be substantially augmented" (para. 416) and called for replacing OSAD by a Centre "to be headed by an experienced person at a sufficiently high level," (para. 422), i.e. at a higher level than the current OSAD and therefore independent of Soviet control.

At the March COPUOS meeting a working group headed by Ewa Nowotny of Austria succeeded in reaching a consensus statement. This was done by ceasing to advocate a Centre as such, but rather suggesting certain new and expanded activities which might be carried out either by the existing OSAD and its Programme on Space Applications, or by a Centre. The new activities would be funded "mainly through voluntary contributions of States, either in money, or in kind" to support a "modest increase in personnel costs." (para. 416). The new activities suggested were scaled down to consist primarily of: a) organizing a fellowship program for training space technologists, b) dissemination of information through panel meetings and seminars; and c) establishing an international space information service so that member states could have better access to existing data banks and sources (para. 423-425).

The U.S. position on a possible U.N. Centre or on any expansion of the present U.N. functions has been that it would not oppose them as such, but would not agree to any increase in funding. The prospect that an independent Centre might diminish Soviet influence and give the United States greater leverage has not been enough to induce it to commit funds; in part this is due to the perception that, given U.S. and Soviet agreement, as space powers, on many issues relating to outer space affairs, a U.N. Center dominated by developing countries might be no more friendly to the United States than the present OSAD. The possibility of a Center still exists, then, and may be debated at UNISPACE, but with active Soviet opposition and a lack of U.S. support, its prospects are slim.

## 6. Possible Outcomes from UNISPACE '82

It is important to keep in mind that UNISPACE '82 has no power to enact laws or programs. Its importance rests on the indirect influence it will exert through the individual delegates, the conference report, and recommendations to the U.N. General Assembly.

Above all, UNISPACE '82 is an occasion in which highly placed delegates from over 100 nations will meet for an extended period to discuss a focussed set of issues. As such, it offers an opportunity for the United States to explain its positions and influence those of other countries, while simultaneously gaining insight into the interests and concerns of others. Along these lines it should be stressed that what transpires on the conference floor may be less important than information gained and influence exerted on the side-lines.

It goes without saying that both the composition of the U.S. delegation, and the quality of the U.S. exhibit, are critical if the United States is to make the most of the conference. Political, technical, and business acumen will all be needed.

The most important UNISPACE outcomes can be divided into four categories:

- **"Atmospherics"** - It is true to say about UNISPACE '82 what can be said about the United Nations generally, that its most important function is to serve as a forum for discussion and a safety-value for competing interests. The level of rhetorical fervor will be high, and the true outcome of the Conference will reside largely in its rhetorical tone and the packaging of its recommendations. The United States therefore has a strong interest in affecting the results of the conference deliberations and the language of the final report. This will require toning down or eliminating overt and implied attacks on western political institutions, free enterprise, and open regimes for communications and remote-sensing. The United States will need to put forward countervailing language that justifies U.S. positions and, where appropriate, places responsibility on the Third World and/or the Soviet Bloc.

Two points should be stressed. First, this can only be done by a U.S. delegation that is both persistent and well-informed. Drafting new paragraphs, coordinating changes with allies, and monitoring the conference text through the various UNISPACE '82 committees is a time-consuming process requiring continuous on-the-spot vigilance. Second, this task is probably hopeless if the United States and its allies go to the Conference without specific initiatives to occupy the conferences's attention and to put the United States in a more positive light. The majority of countries at UNISPACE will be generally opposed to U.S. interests and hostile to the United States itself; given the large number of issues and the length of the Conference, the United States will find itself trying to plug a very leaky dike unless it can introduce or support proposals that offer at least some developing countries the prospect of substantive gains, (see Section 7 for further elaboration).

o **Education and Salesmanship** - UNISPACE '82 will serve to publicize the important uses of space technologies, both to the general public and to the conference participants. In this respect the United States needs to keep in mind both its competition and its audience. The competitors are the Soviet Union, which (in this 25th anniversary year of Sputnik) is expected to mount a major publicity campaign that includes bringing several cosmonauts to the conference; and the emerging space powers, especially France and Japan, who are attemping to impress on the world their status as full-fledged space competitors. The audience consists mainly of developing country government officials with responsibilities for scientific and technical training and project implementation. These people will be influenced both by their overall impressions of the vitality of respective national programs, and by specific technologies and systems that can be of use to their countries and, more specifically, to their own ministries. The United States can gain by stressing both its unmatched experience in using space systems for development, and its willingness to cooperate in furthering such projects. To this end, it is critical that both U.S. Government agency and private sector capabilities be emphasized, and that other countries perceive our public and private sectors as working together in harmony. If not, the French and Japanese will profit from their high degree of coordination between government and industry, which lends credibility to commercial propositions in the areas of remote-sensing and communications. The U.S. exhibit can play a key role in affecting foreign perceptions of this issue.

o **Effects on other international fora** - Though UNISPACE '82 itself has no power beyond making recommendations, it may decisively affect discussions at other meetings that do, particularly the ITU. Many of the same people that attend UNISPACE '82 will also attend upcoming ITU sessions, especially the Plenipotentiary. Recommendations in the conference report will undoubtedly be used at the Plenipotentiary and future RARCs to buttress demands for access to GSO, preferential frequency allocations, and technology transfer. Special attention needs to be paid to relevant paragraphs of the conference report.

o **U.N. structure for space affairs** - The conference may make specific recommendations about expanding or restructuring the Outer Space Affairs Division, including establishing an independent Centre for Outer Space

Affairs. Though the United States opposes spending more money at the United Nations, or setting up new U.N. structures, it should be kept in mind that it is in the U.S. interest not to be seen as the sole obstacle to such proposals or, perhaps worse, as "ganging up" with the Soviet Union against the developing world. Such a perception will work strongly to French and Japanese advantage.

A second area of concern is the military uses of space. The United States would prefer not to discuss this issue extensively at UNISPACE '82. Though our first wish would be to put the issue in the U.N. Disarmament Committee, such a proposal is unlikely to satisfy those wishing to raise militarization at UNISPACE '82. An alternative is for the United States to support a recommendation to place this item on the future agenda at COPUOS, a far less public arena than UNISPACE '82.

## 7. Possible U.S. Initiatives at UNISPACE '82

As argued above, the United States might have something to gain from taking to the conference several initiatives for enhanced international cooperation in space. The rationale for initating proposals at UNISPACE '82 rests on three premises: 1) that it is better to obtain as much advantage as possible from U.S. participation at an international conference, 2) that the United States can benefit economically and politically from the attempt, and 3) that cooperating more broadly might diffuse some of the criticism that the shuttle, our most visible new step into space, will primarily serve military missions. The latter criticism is likely to be particularly strong at the conference. Effective attempts at presenting initiatives might also serve to some extent to redress the years of poor U.S. preparation for international conferences.*

The Administration is now considering what initiatives, if any, the United States should offer at UNISPACE '82. OTA has also generated a set of possible initiatives, some of which may duplicate those considered by the Administration. The options presented here divide naturally into two categories: unilateral initiatives that require only a decision by the United States to carry them out, and multilateral initiatives that would require extended negotiation to determine whether other countries of the world are willing to participate and on what terms.

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*See OTA Report, WARC '79, op. cit.; H.R. 1957 and S2469 (97th Congress)

## Unilateral Initiatives

**o Presidential address at UNISPACE '82**

An address by the President to UNISPACE '82 could have a major impact on the way in which the United States is viewed at the conference, especially if it were used to deliver one or more U.S. initiatives for the conference; it could be delivered by an Intelsat satellite. The purpose of the address, in addition to announcing certain U.S. initiatives, would be to show United States concern for the issues to be discussed at the conference. Such a clear statement of American concern and good will could greatly enhance the ability of the U.S. delegation to influence the outcome of the conference.

**o Commitment to Continuity of Landsat MSS Data Through the Decade**

Commitment to continuity of data throughout the decade is one of the most important policy decisions that current domestic users of Landsat multispectral scanner (MSS) data would like to see made by the U.S. government.* Foreign users also have the same need, as they plan their use of remote sensing systems to monitor and control their use of renewable and nonrenewable resources. The United States made a grand effort during the 70s to involve the international community in using Landsat data. It promoted the sale of ground stations to receive Landsat data, and it guaranteed to sell Landsat data to anyone who wished to buy them at a very reasonable cost. In addition, through NASA and the Agency for International Development, the United States trained many foreign nationals in using Landsat data. Recently, however, lack of clear domestic policy has made the continuity of Landsat data highly uncertain.

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*Civilian Space Policy and Applications Op. Cit., pp. 53-67.

It would be most desirable for the United States to guarantee continuity of Landsat data through the 90s. Failing that, the United States could at least publically recognise the problem at UNISPACE '82 and offer to work with other nations to solve it.

- **U.N. Centre for Outer Space**

The United States may wish to reconsider its previously unenthusiastic support of the Centre which will be proposed at UNISPACE '82. If such a Centre were established it would provide an independent forum for space issues separated from the presently politicized U.N. Outer Space Affairs Division (OSAD). The OSAD is presently located in the Department of Political and Security Council Affairs which is controlled by the Eastern Block nations. By actively supporting the Centre, the United States would have greater control over its structure and function.

The present U.S. position is that it will support the Centre only if it does not increase the U.S. contribution to the United Nations. However, inkind support is one acceptable method for countries to support the Centre. The United States could offer to create a pool of experts who would be detailed to the Centre for limited periods of time. An offer by the United States at UNISPACE '82 to commit several man years per fiscal year would be well received.

- **International Payload Specialists**

Presently, countries that have purchased spacelab flight time have been able to designate "payload specialists" who tend their experiments on the shuttle. Because only the developed countries have an immediate interest in pursuing microgravity research, there is little chance that the nationals of less developed countries will be able to participate in shuttle flights. The United States, recognizing that the 1967 Outer Space Treaty designates those who travel to outer space as "envoys of mankind," could announce that it would train a pool of international payload specialists to take advantage of the shuttle's capabilities.

As a more daring initiative, the United States could announce that it would fly a Soviet cosmonaut on the space shuttle if the Soviets would agree to fly a U.S. astronaut on their Salyut space station.

The advantage to announcing either of these invitations is that neither requires a substantial expenditure and neither involve the transfer of sensitive technology. However, both initiatives represent the kind of a good will gesture that would be appreciated at UNISPACE '82.

For the United States to guarantee continuity of MSS data until the end of the decade would serve both domestic and foreign needs and be a welcome gesture to those countries that have invested in Landsat ground stations. In the event that private owners fail to launch their own satellites, such a policy would also require the United States to fly Landsat D' and a follow-on land remote sensing satellite after that. Because MSS technology is well known and inexpensive compared to the alternatives, this would not necessarily be a costly commitment. Because it would serve domestic needs as well, it would be a comparatively cheap investment in international goodwill.

**Multilateral Initiatives**

- **Use of TDRSS Transponders by Developing Nations**

The United States has a major opportunity to improve its relations in the developing countries by assisting in upgrading their communications service and thereby enhancing their prospects of economic growth by creative use of the Tracking and Data Relay Satellite System (TDRSS). This system, originally designed to support the shuttle and satellites in low earth orbit will become operational in the near future. Three TDRSS satellites are scheduled for launch in the next 18 months; in addition to its other equipment, each will have 12 C-Band transponders. Originally these C-Band transponders were to have been used by Western Union. However, Western Union has abandoned these plans and this capacity will revert back to NASA. This C-Band capacity might be used by the developing countries.

TDRSS-I, scheduled for launch July 4, 1983, could be configured to cover the entire South Pacific, where distances between islands makes traditional communication methods such as cable or point-to-point microwave links ineffective. TDRSS-II and III could be used to provide a similar service to countries in Africa and Asia.

This initiative would cost relatively little but would demonstrate U.S. commitment to the welfare of the developing world.

- **GLOBESAT**

This initiative would propose to establish an international remote-sensing satellite system modeled loosely on the Intelsat communications network.* The U.S. could take the lead in calling for negotiations between interested parties to draw up an interim charter defining the rights and duties of partners and the cost of membership. It could also propose that the upcoming Landsat D system be used as the initial technology, with Landsat ownership and operation to be transferred incrementally to Globesat. Globesat would then design and purchase its own satellite system, drawing on U.S., French, Japanese and other available technologies.

A Globesat system would allow Third World and other countries to participate directly in ownership and control of a civilian remote sensing system, thereby off-setting fears of commercial and military exploitation. It would help prevent the likely erosion of the U.S. lead in remote sensing systems as a result of the national systems of France and Japan, while reducing the costs to the U.S. of obtaining civilian data. Such a U.S. initiative would be likely to gain important political advantages for the United States with interested countries and within a Globesat alliance itself.

- **Support for Regional Learning Centers**

Many, if not all of the developing countries are concerned with providing social services to their dispersed populations. Satellites, though an efficient means to deliver such services, are useful only if programs exist to be delivered and if there are indigenous learning materials (e.g. books and study plans) to support such program.

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*Discussed in some detail in Civilian Space Policy and Applications, op. cit., pp. 298-300.

Since 1975, the United States, in cooperation with other nations, has carried out many carefully controlled, successful experiments which used space technology for delivering social services such as health care and education. These experiments have created a limited cadre of personnel from both developed and developing countries who understand both the technology and the needs of the ground segment. These persons could be used to assist in training other personnel and in developing learning materials.

The United States could offer to initiate and support a long term program to train indigenous experts. Such a program would identify and coordinate groups of qualified individuals who would travel to different countries and regions to conduct the necessary training courses. By organizing this program in such a way that the costs were shared by the participating and host countries this effort could be accomplished with little cost to the United States.

- **Integrated Global Study of the Earth**

How long will Planet Earth remain habitable? Burgeoning population pressure and the consequent loss of resources such as forests, and the release of the byproducts of civilization into the atmosphere, ocean, and the land, has caused concern that significant portions of the planet may become relatively less habitable in the next quarter century or so. The scale of our ability to alter the local environment is such that other regions are necessarily affected by these environmental alterations. For example, the release of large amounts of $CO_2$ by deforestation and by burning fossil fuels or the depletion of stratospheric ozone by releasing flourocarbons could make substantial global changes in the productivity of the biosphere and, hence, its ability to sustain human life.

Even to determine whether concerns about $CO_2$ buildup or ozone depletion are justified will require an international cooperative effort to collect the needed data. A recent multidisciplinary workshop on Global Habitablity sponsored by NASA (June 20-26, 1982) concluded that to assess the potential effects that these or similiar changes in the ocean or land mass might have on our environment will be difficult, yet will also require an international program because the effects are subtle and must be tested worldwide. Many of the data can be best collected by satellite. In addition a considerable portion of the data will require collection on the ground in the many different geographical regions of the earth.

A U.S. initiative to join with other nations in collecting and analyzing the necessary data, whether by satellite or on the Earth could be a welcome plan to many other countries, of the world, particularly the developing countries, especially if it were also accompanied by plans to help them build their own scientific and technical infrastructure. There is too little time between now and UNISPACE '82 to do more than offer to negotiate the terms of such an agreement. However, a major project of this sort, in which the U.S. took the lead but other nations were substantial partners, could give the United States a major political advantage at UNISPACE '82.

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# ISSUES RELATING TO THE 1982 SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE 82)

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March 5, 1982

## SUMMARY

The United States will participate in the Second United Nations Conference on Exploration and Peaceful Uses of Outer Space (UNISPACE 82) from August 9-21, 1982 in Vienna, Austria. Although the conference is being planned as a discussion of scientific and technical issues concerning space activities, it seems likely that political and legal issues will arise as well. Among the broad international issues of which Congress may wish to be aware are the following:

- Increasing national and international concerns that space is becoming militarized (weaponized), and the arms race may spread into space. military
- The controversy over whether countries should have the right of prior consent over distribution of remote sensing data concerning their territory, and reception of programs from direct broadcast satellites. prior consent for sensing; DBS reception
- Concerns of the less developed countries (LDCs) about being frozen out of access to space resources, including use of the geostationary orbit and resources on the Moon and asteroids. LDC access to space
- LDC desires to receive technical assistance from developed countries to allow them to benefit from space activities. TA to LDC
- The controversy over utilizing nuclear power sources in space. nuc in space
- The proposal to establish a United Nations Centre for Outer Space. UN Center?
- Proposals to have the United Nations control international reconnaissance and/or remote sensing satellites. UN remote sensing?

Issues relating to U.S. preparations for UNISPACE'82 include:

- Will the U.S. delegation be adequately prepared to deal with political as well as technical issues? U.S. political preparedness?
- Will the U.S. delegation be of adequate size, and will the chairman and other members of the delegation be named in a timely manner? U.S. deleg?

This paper describes these and other issues of potential congressional concern as the United States prepares for UNISPACE 82.

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# ISSUES RELATING TO THE 1982 SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE 82)

## INTRODUCTION

From August 9-21, 1982, the United Nations will sponsor the Second U.N. Conference on the Exploration and Peaceful Uses of Outer Space (also called UNISPACE 82) in Vienna, Austria. Although the conference was designed to deal only with scientific and technical issues, it is quite likely that political and legal questions will arise as well.

During 1981, a dispute at the United Nations over who would be chairman of the U.N. Outer Space Affairs Division postponed a U.S. decision to participate in UNISPACE 82. As a result, the United States only began full-scale preparations for the conference in early 1982.

This briefing paper identifies issues in three area: issues concerning U.S. preparations for UNISPACE 82, issues concerning global space policy, and issues concerning the United Nations. The purpose of the paper is to highlight a few issues which may be of particular concern to Congress, not to provide a definitive list of all possible issues which may arise in connection with UNISPACE 82 (such a list would be very long). There are also a large number of issues concerning international cooperation in space generally, especially since the United States has so many international cooperative programs. Relations between the United States and the European Space Agency in the aftermath of the U.S. abrogation of the agreement for the International Solar Polar Mission is a case in point. Those issues have been treated in great detail in other works prepared by the Congressional Research Service, and in hearings and panel discussions by the House Committee on Science and Technology. A list of references to these and other documents which might be useful in acquiring a full understanding of current issues on international space cooperation, appears at the end of this report.

CRS-3

## ISSUES CONCERNING U.S. PREPARATIONS FOR UNISPACE 82

### 1. BREVITY OF PREPARATION PERIOD

During 1981, the U.S. refused to participate in preparations for UNISPACE 82 because of a dispute at the United Nations over who would become director of the Outer Space Affairs Division. Ordinarily, the director of the division would have served as head of the UNISPACE 82 conference. The director of the division, a Czech, retired and the United States expected that his deputy, an American, would be named to succeed him; the Soviet Union insisted that another Czech be made head of the division. Despite attempts by the United States to reach a compromise position (for example, the United States agreed to allow someone other than the director of the division to serve as head of UNISPACE 82), the dispute was not resolved until the final days of December when an agreement was reached whereby the American would be named Acting Director until the UNISPACE 82 conference, at which time he would be formally named director, and the Czech candidate would be his deputy and ascend to the position of Director when the American leaves.

As a result, the United States only began full-scale preparations for UNISPACE 82 in early 1982, and the State Department Office of the U.S. Coordinator for UNISPACE 82 was not established until February. Other countries have had two years to prepare for the conference. The U.S. national paper, which was to have provided U.S input into the draft UNISPACE conference report, has not been submitted to the U.N. yet. The delegation has not been named (see next issue), and exhibits must be prepared in haste. The question has arisen as to whether the United States gained enough from the exercise to have made it worthwhile.

## 2. STATUS OF THE U.S. DELEGATION FOR UNISPACE 82

Because of the delay explained in the previous issue, the chairman and members of the U.S. delegation for UNISPACE 82 have not yet been named. In addition, while the State Department had planned originally to have as many as 30 members of the delegation, the Reagan Administration has ordered that all delegation sizes be cut by one-third, and the State Department is now suggesting that the official delegation may have as few as 10 people (although there will be a larger corps of people assisting the delegation at the conference).

As with other U.N. conferences, the question has arisen as to how well prepared the delegates will be, particularly considering the short amount of time between the date they will be named as delegates and the beginning of the conference. Part of this issue concerns whether they will be adequately briefed on U.S. positions regarding non-technical issues, such as those listed elsewhere in this report (the U.S. position regarding UNISPACE 82 is that it is a technical, rather than a political conference, and therefore only technical issues should be discussed). Another part concerns whether the delegation should be comprised of individuals with primarily technical backgrounds, or if representatives from political, legal, economic, or diplomatic backgrounds should be included. This will be a particularly difficult matter to deal with considering the small size of the delegation.

Congress may wish to provide direction to the State Department concerning the development of U.S. position papers regarding some of the political and legal questions likely to arise at UNISPACE 82.

## 3. INVOLVEMENT OF NON-GOVERNMENT REPRESENTATIVES IN UNISPACE 82 PREPARATIONS

In some cases, U.S. preparatory activities have benefitted from the viewpoints of representatives outside the Government. For example, the State Department established a Public Advisory Panel, consisting of persons with a wide range of views from the private sector and public non-profit organizations, for the 1979 World Administrative Radio Conference. There appears to be little activity with regard to obtaining views outside the Government for UNISPACE, possibly because of the short amount of time left for U.S. preparations. How important this will be in terms of U.S. performance at the conference is unknown.

The American Institute of Aeronautics and Astronautics (AIAA), a professional society of aerospace engineers, has taken the lead in getting the private sector to put on exhibit at the conference. These exhibits will form an important part of the impression the United States makes at the conference, and Congress may wish to provide guidance to the State Department regarding what assistance it might provide to the private sector, especially to smaller companies which might not be able to afford to participate in the conference.

A Non-Governmental Organization (NGO) committee of the international NGOs officially attached to the United Nations has been established for UNISPACE 82 to conduct a meeting parallel with the governmental UNISPACE 82 conference. Many of the political issues identified in this report are likely to be discussed at the NGO meeting instead of at the formal UNISPACE 82 conference. Because of the delay in U.S. preparations for the conference, U.S. funding which might have been made available for the NGO committee's activities has not been forthcoming. Congress may wish to provide guidance to the State Department concerning funds for the NGO activities.

## 4. U.S. INITATIVES AT UNISPACE 82

The question has also arisen as to whether the United States plans to offer initiatives at UNISPACE 82, or if it will only seek to limit the negative impact that the initiatives of other countries might have on U. S. interests. If the United States plans to promote certain initiatives, what will they be, and what is the timetable for submitting them to the United Nations? Must they be ready by the time of the next (and last) meeting of the UNISPACE 82 preparatory committee on March 22, 1982? What is the timetable for preparing U.S. position papers concerning these initiatives, and for attempting to gain the support of other nations?

CRS-7

## ISSUES CONCERNING GLOBAL SPACE POLICY

### 1. MILITARIZATION OF SPACE

The utility of spacecraft for military reconnaissance, weather observation, communications, navigation, and geodesy has been recognized and exploited since the beginning of the space age. The concern which is growing in national and international circles is not directly related to these uses of spacecraft, but rather to the use of weapons in space.

At this time, only the Soviet Union has an operational weapons system for use against satellites, called an antisatellite (ASAT) or killer satellite. The Soviets have made nineteen tests of this system since 1968 (most recently in March 1981). In 1977, the U.S. Secretary of Defense termed the Soviet system operational. (In 1981, the magazine Aviation Week and Space Technology reported that the Soviets had placed a "battle station" in orbit, armed with infrared homing vehicles. If true, this would represent a new Soviet space weapons development.)

In response to the perceived Soviet threat, the United States embarked on its own program to develop an ASAT device; although the schedule is classified, tests of the device are expected to begin in 1983. At the same time, however, the United States initiated a series of talks with the Soviets regarding an ASAT limitation treaty. Three rounds of talks were held in 1978 and 1979, without resolution. In the fall of 1981, the Soviets introduced a draft treaty at the United Nations to ban the stationing of weapons in space. This draft treaty has been referred to the U.N. Committee on Disarmament for consideration.

Both the United States and Soviet Union are reported to be developing advanced space weaponry, including directed energy weapons (lasers or particle beams).

## 2. PRIOR CONSENT--REMOTE SENSING AND DIRECT BROADCAST SATELLITES

Since 1972, the United States has launched three land remote sensing satellites (LANDSAT 1, 2 and 3). The data from these spacecraft can be used to survey crops, minerals, land usage, and many other things. U.S. policy is to make this data available to anyone who wants it--the "open skies" policy. Some countries feel that they should have the right of "prior consent" over who is given access to data about their resources for fear that the data might be used by one nation for strategic, political or economic purposes not in accordance with the desires of the nation which the data concerns. The United States argues that the data itself should be openly available, while the information derived from that data by the purchaser is the property of that analyst or sponsoring entity.

Similarly, some countries are concerned about one country transmitting television programs across national boundaries without the prior consent of the government concerned. This is becoming increasingly important with the advent of direct broadcast satellites (DBS) which can transmit to individual home receivers, rather than to a general receiver for subsequent relay to individual television sets. The United States has a policy of free flow of information, and therefore does not accept the principle of prior consent for broadcast satellites.

Both of these issues have been debated at the United Nations for many years without resolution. One suggestion has been that the U.N. itself take charge of remote sensing data.

## 3. "OWNERSHIP" AND USE OF GEOSTATIONARY ORBIT

Space has been the province of very few countries during the past two decades, and these countries have been able to use space as they wish. Beginning in the 1970's, less developed countries (LDCs) began calling for plans which would guarantee their future access to certain limited space resources.

One example of this is the controversy over geostationary orbit (GEO). This orbit lies above the equator at an altitude of 35,800 kilometers (22,300 miles). A satellite placed there will retain the same position relative to any point on Earth, and GEO is therefore very useful for applications such as communications and meteorology. The explosion in demand for domestic communications satellite has prompted concerns by many countries, especially LDCs, that there will not be enough "slots" in GEO for their satellites. Proposals were developed for providing at least one GEO slot to every country of the world, whether or not the country has plans for using it. The United States and some other developed countries oppose this type of scheme, not only because it will deny access to many parts of GEO (even though there may be no plans for placing satellites there), but technological advances may solve the problem.

A corollary issue was raised by eight countries that are on the equator when they claimed in the 1976 Bogota Declaration that they own that part of GEO which transverses their countries. This contention has been rejected by the United States and many other countries, since the 1967 Outer Space Treaty prohibits claims of national sovereignty in outer space. One difficulty is that there is no internationally accepted defnition of where outer space begins (although most countries agree that it is well below the 35,800 kilometers of GEO).

## 4. OWNERSHIP OF RESOURCES ON THE MOON AND OTHER CELESTIAL BODIES

Another aspect of the debate over access to the resources of outer space concerns utilization of resources on the Moon, asteroids, and other celestial bodies. In 1979, the United Nations concluded an Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (called the Moon Treaty). The agreement was opened for signature in 1979; five countries must sign and ratify the treaty before it enters into force. By the end of 1981, 11 countries had signed the treaty, but only three had ratified it (Chile, the Philippines, and Uruguay).

The Moon Treaty resembles the proposed Law of the Sea Treaty in terms of sharing resources with the other countries of the world under the "common heritage of mankind" concept. Opponents of the treaty see it as another attempt by the LDCs to control and profit from investments and activities of the industrial nations, and claim that it will discourage private firms from investing in space.

Since the activities which would be governed by the treaty probably would not be possible within this century, the question has arisen as to why the United States (and other countries) agreed to proceed with drafting and finalizing the treaty. The response appears to include the fact that the United States was hoping that to gain cooperation from other countries in resolving issues such as remote sensing and direct broadcast satellites.

Neither the United States nor the Soviet Union, the only two countries with a demonstrated capability for sending spacecraft to the Moon, have signed the treaty.

## 5. TECHNICAL ASSISTANCE TO THE LESS DEVELOPED COUNTRIES

The LDCs have called for programs of technical assistance to enable them to exploit technology developed by the industrial countries as part of the New World Information Order and the New Economic International Order. Many areas related to space activities, including communications and remote sensing, are part of the desired technical assistance programs.

The United States has made many promises of technical assistance, but has been slow in delivering on those commitments both because of a dispute over how much money the United States should contribute, and because of disputes over what mechanism should be used for the funding (whether it should be through voluntary contributions to U.N. activities or through the regular assessed budgets of U.N. and its specialized agencies). The United States feels that such activities should only be funded through voluntary contributions, while the LDCs would like funding from both avenues. Recently, the promises have also been diminished: at a recent meeting of UNESCO, the United States pledged to provide $100,000 over an indefinite period of time under bilateral arrangements outside the UNESCO program, while other countries pledged substantial contributions to the UNESCO-sponsored activities (the Soviet Union, for example, pledged the equivalent of $2 million in money, materials, study grants, and expert services).

The United States has provided assistance to LDCs in other ways, however. For example, the Satellite Instructional Television Experiment (SITE) project in India provided experience with using satellites to broadcast educational television programs to more than 5,000 Indian communities. The U.S. also assists in remote sensing data utilization and communications training programs. The question remains as to whether the United States is contributing enough.

This is an
opportunity!
Cheap foreign aid!

## 6. NUCLEAR POWER SOURCES IN OUTER SPACE

In January 1978, the Soviet satellite Kosmos 954 unexpectedly decayed from orbit. The satellite, probably used for ocean surveillance activities, used a nuclear reactor for power, and radioactive debris was spread over a wide area of northern Canada. Ordinarily, when satellites of this type have completed their mission, the portion of the craft which contains the nuclear reactor is separated from the rest of the satellite and is boosted into a very high orbit from which it will not decay until the radioactive material no longer presents a danger. K954 malfunctioned for reasons not made clear by the Soviets.

In the aftermath of the K954 incident, the matter of using nuclear power sources in space came before the United Nations. Some countries have argued in favor of prohibiting all nuclear power sources from satellites, while others have called only for pre-launch notification if a satellite is using a nuclear power source. One difficulty with these arguments is that they have not differentiated between nuclear reactor power sources like those of K954, versus non-reactor nuclear power sources like radioisotope thermal generators (RTGs) which use heat from the decay of a small amount of plutonium-238 to generate electricity. The Soviet Union is the only country which uses nuclear reactors in space; the United States uses RTGs for powering spacecraft that will be used for long periods of time (particularly planetary spacecraft).

Although the matter has not been resolved at the United Nations, the Soviets have resumed flights of their nuclear reactor powered spacecraft. The United States is continuing with plans to fly RTGs on future missions.

## ISSUES CONCERNING THE UNITED NATIONS

### 1. PROPOSAl FOR A UNITED NATIONS CENTRE FOR OUTER SPACE

The Secretary-General of the UNISPACE 82 conference, Yash Pal, is in charge of the effort to develop a draft conference report prior to the August meeting. The draft report will be discussed, amended (if required), and approved at the conference.

One aspect of the draft report is to create a U.N. Centre for Outer Space. The center would have a wide variety of duties including: organizing and operating a space information service which would provide access to space data; participating in and conducting various studies; and assisting countries to choose, execute, and make beneficial applications of space. The draft report was released for discussion only at the January 1982 meeting of the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS), which serves as the preparatory committee for UNISPACE 82, so countries have not had a chance to formally comment on its provisions yet. The United States does not have a formal position on the proposal, but the Reagan Administration generally opposes the creation of new international agencies. In the discussion at the January COPUOS meeting, other countries expressed concerns that the new center would duplicate activities of existing U.S. agencies and departments, although at least one country (Egypt) supported the proposal and wanted to take it a step further (probably a reference to the idea of creating a United Nations Space Agency).

The draft report will be discussed is more detail at the next COPUOS meeting from March 22 - April 2, 1982. This will be the last COPUOS meeting prior to UNISPACE 82.

## 2. PROPOSALS TO HAVE THE UNITED NATIONS CONTROL CERTAIN SATELLITE SYSTEMS

Debate over the dissemination of remote sensing data has led to the suggestion that the United Nations take charge of at least disseminating such data. This concept has been discussed for many years without resolution, and is sometimes referred as the establishment of a Global Resources Information Center. The provisions in the draft UNISPACE 82 conference report discussed previously, which related to U.N. Centre for Outer Space, refer to activities related to providing a bank of space data which would be made available to all countries.

Another proposal is to establish an International Satellite Monitoring Agency which would use satellite reconnaissance data to verify whether countries are abiding by the treaties they sign. This matter has been discussed in disarmament circles since at least 1978, and a United Nations Panel of experts issued a report on this matter in 1981, which will be discussed at the Second Special Session on Disarmament at the United Nations this summer (prior to UNISPACE 82). The matter may also arise at UNISPACE 82, however.

## LIST OF REFERENCES

Science Policy Research Division. Congressional Research Service. Soviet Space Programs 1971-75. Volumes I and II. Prepared for the Committee on Aeronautical and Space Sciences, U.S. Senate. Committee Print. Washington, U.S. Govt. Print. Off., 1976. Vol. I - 668 p. Vol. II - 221 p. [An updated edition of this report, covering the years 1976-1980, is now being prepared for the Senate Committee on Commerce, Science, and Transportation.]

-------. United States Civilian Space Programs: 1958-1978 (Volume I). Prepared for the Committee on Science and Technology, U.S. House of Representatives. Committee Print. Washington, U.S. Govt. Print. Off., 1981. 1339 p. [Volume II, covering applications satellites, is now in preparation.]

-------. World-Wide Space Activities: National Programs Other Than the United States and Soviet Union. Prepared for the Committee on Science and Technology, U.S. House of Representatives. Committee Print. Washington, U.S. Govt. Print. Off., 1977. 607 p.

Sheldon, Dr. Charles S. II and Marcia S. Smith. Space Activities of the United States, Soviet Union, and other Launching Countries/Organizations. Congressional Research Service, Library of Congress, 1982. [In press]

Smith, Marcia S. 1979 World Administrative Radio Conference: Implications for U.S. Preparations for Future ITU Conferences and the Space Services. Congressional Research Service, Library of Congress, 1981. CRS Report No. 81-201 SPR. 101 p.

-------. Antisatellites (Killer Satellites). CRS Issue Brief 81123.

-------. Earth Resources Satellite System (Landsat). CRS Issue Brief 78007.

-------. Space Policy and Funding: NASA AND DOD. CRS Issue Brief 78093.

-------. Space Shuttle. CRS Issue Brief 81175.

U.S. Congress. House. Committee on Science and Technology. Subcommittee on Space Science and Applications. International Space Activities [1978]. Hearings, 95th Congress, 2nd session. May 16, 17, 18, 1978. Washington, U.S. Govt. Print. Off., 1978. 347 pp.

-------. International Space Activities, 1979. Hearings, 96th Congress, 1st session. Sept. 5 and 6, 1979. Washington, U.S. Govt. Print. Off., 1979. 247 pp.

-------. International Space Activities; report prepared by the Subcommittee on Space Science and Applications. Committee Print. Washington, U.S. Govt. Print. Off., November 1978. 52 pp.

-------. Panel Discussions on International Space Activities. Hearings, 95th Congress, 1st session, June 20, 21, 1978. Washington, U.S. Govt. Print. Off., 1978. 167 pp.

# THE HISTORY AND DEVELOPMENT OF SPACE LAW

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Note: ABA instructions were to avoid footnotes as much as possible but if necessary to insert them into the text. I followed these instructions although I did not agree with them because the subject should have many footnotes inserted at the end of the paper. EG.

# THE HISTORY AND DEVELOPMENT OF SPACE LAW

## I. INTRODUCTION

Space law has been developed to apply both to outer space as a geographic area and to functions performed in that environment. Space law is both national and international and its development during the past twenty-five years has produced a new branch of international law. This body of law has grown from the necessity of creating new institutions and guidelines to govern the expanding use of space science and technology in improving functions and providing new services on the Earth. The term "space law" has been subject to misinterpretation by those who assumed that it concerned only esoteric matters in outer space; perhaps a more definitive designation would be "legal problems arising from the uses and exploration of outer space." Laws were generated for the variety of uses for earth-oriented applications.

A knowledge of space science and technology is essential for the solution of legal problems involving existing space law and proposals for its future development. Adjustments must be made to unique features of space technology and its applications: (1) the launching of satellites is so expensive that it was undertaken by governments; (2) satellites are inevitably international as they orbit the Earth in approximately 90 minutes without regard for national boundary lines; (3) every national space program has international aspects; (4) some space applications are attractive to private industry, thus creating problems of the relation between government and the private sector; (5) unusual safety and health standards are required and involve government regulation; (6) the United States is party to space treaties providing for government supervision of space activities, both governmental and non-governmental; (7) space-obtained data must be integrated with ground and air-based information for maximum effectiveness in solving certain problems; (8) data and information from satellites is unique in contributing to the analysis of regional problems; (9) the manufacture, operation and management of spacecraft and the interpretation of data and information are highly technical, requiring specially trained experts; and (1) national and international institutions are required for certain space activities while other space-related functions may be grafted on to existing institutions.

Space technology made it possible to use the environment of outer space for a multiplicity of purposes beneficial to the Earth. The most dramatic example is space communications which have become an international commercial global service. Meteorology has been revolutionized by using satellites, the data having been routinely used for weather prediction for many years. Remote sensing of the Earth by satellites has produced synoptic data used for improving mapping, land management, and water resources; detecting natural resources, blighted crops and forest fires; dealing with urban planning and transportation. Surveillance to deter aggression also became practicable by using space vehicles. The exploration of outer space has yielded knowledge of the universe, far beyond our original expectations. The number of nations with space and space-related programs has been increasing as requirements have grown for practical benefits to be derived from space-based craft. Commercialization of space products can be expected to increase in the future.

Added to the unique features of space technology was an unusual conceptual background, both national and international, that furnished the basic ideas for policy principles adopted in the formulation of space law. In the United States, scientists and engineers became a political force following the advent of the atomic bomb, organizing to emphasize peaceful purposes, international cooperation, analytical publications, and participation in government. They played a major role as part of the international scientific community that organized the International Geophysical Year, an 18-month period between July 1, 1957 and December 31, 1958, during which 67 nations cooperated to study mankind's four environments: earth, oceans, atmosphere and outer space. The original experiments to explore outer space were part of the IGY program with projects planned by the United States and the USSR. Scientists and engineers who participated in the IGY were internationally minded, project-oriented, and well aware of the relationship between national and international matters. /International Cooperation and Organization for Outer Space. By Eilene Galloway, U. S. Senate document No. 56, 89th Congress, 1st session. Senate Committee on Aeronautical and Space Sciences, 1965. pp. 353-354./

The legal community had also produced basic concepts which found their way into developing space law. International lawyers had long been interested in comparing the extension of sovereignty over the seas with airspace, speculating on the altitude to which sovereign airspace extends. /Space Law: A Symposium. Edited by Eilene Galloway. Senate Special Committee on Space and Astronautics, 85th Congress, 2nd session. Committee print. December 31, 1958. 573 p./

The dramatic orbiting of the first satellite by the Soviet Union on October 4, 1957 surprised the world and the instantaneous reaction was the impulse to use foresight in formulating laws to ensure that outer space be used only for peaceful purposes for the benefit of all mankind. Outer space must not become an arena for war.

An introduction to the history and development of space law can be outlined by setting forth basic policy decisions in major U. S. national laws regulating space activities and in international space treaties and agreements. This entire complex would have to be taken into account in dealing with any legal matter arising from a space activity. Every space problem is multidisciplinary and in addition to legal aspects may involve factors that are political, economic, scientific, technological and cultural. An increasing number of nations have entered the space field, or are planning to do so, and a more complete coverage of the subject would require the addition of their laws, institutions, and regulations.

## II. MAJOR U. S. NATIONAL SPACE LAWS

A. The National Aeronautics and Space Act of 1958, as amended (72 Stat. 426, July 29, 1958) was the product of a legislative proposal sent to the Congress on April 2, 1958 by President Eisenhower, and hearings held by the "blue ribbon" Congressional committees formed for the purpose of determining how the United States should be organized to conduct a preeminent space program: the Senate Special Committee on Space and Astronautics whose chairman was the Senate Majority Leader, Lyndon B. Johnson; and the House Select Committee on Astronautics and Space Exploration chaired by the House Majority Leader, John W. McCormack. These special committees had available the intensive hearings on the U. S. Satellite and Missile Situation held by the Senate Armed Services Committee's Preparedness Investigating Subcommittee beginning on November 27, 1957. The orbiting of the Soviet Union's first two sputniks demonstrated their capability of launching intercontinental ballistic missiles. Congressional reaction was to investigate the impact on national defense while simultaneously recognizing the unique opportunities opened by space technology for peaceful civilian space programs which could benefit mankind. (Final Report, Senate Special Committee on Space and Astronautics, S. Res. 256, 85th Congress. 86th Congress, Senate report No. 100. March 11, 1959. 76 p. National Aeronautics and Space Act of 1958, as Amended, and Related Legislation. Senate Committee on Commerce, Science, and Transportation. 95th Congress, 2d session. committee print. Dec. 1978. 185 p.)

Congress declared in the NASA Act "that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind." (Sec. 102 (a)). Upwards of 90 percent of space activities were located in the Dept. of Defense, but it was decided to create a new civilian agency to develop space applications which did not come within the jurisdiction of military affairs. The Dept. of Defense was given responsibility for "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States..." (Sec. 102 (b)).

The National Aeronautics and Space Administration (NASA) was created by using the existing National Advisory Committee for Aeronautics as a nucleus and adding responsibilities for astronautics. The remarkable foresight of this decision was demonstrated by NASA's success in developing a variety of practical civilian space applications. These could not have been developed within the Department of Defense whose legislation does not authorize such activities. Indeed, the sense of urgency was so great that during the time NASA was being considered, Congress passed two laws to provide funds and authorize the Department of Defense to engage in nonmilitary advanced space projectsfor one year as designated by the President. (Public Law 322, February 11, 1958 and Public Law 85-325, February 12, 1958). Nor could NASA's program have been successfully developed if the civilian space function had been assigned to a division within an existing agency where it would have been compelled to fight for its funds among other competing pressures.

The NASA Act as passed by Congress was different in several major respects from the original legislative proposal introduced as S. 3609, April 14, 1958 and H. R. 11881 which became H. R. 12575. Mainly, the Senate Committee questioned the assumption that a total U. S. space program could result from dividing space programs between agencies and declaring that they should cooperate voluntarily. Civilian space activities were foreseen as involving more agencies than NASA which could not be expected to exercise control over other agencies by means of an internal advisory committee. The law, therefore, provided Title II; Coordination of Aeronautical and Space Activities: the National Aeronautics and Space Council whose original membership was composed of the President as Chairman, the Secretary of State, the Secretary of Defense, the NASA Administrator, the Chairman of the Atomic Energy Commission and other appointments from government and the private sector. When Senator Lyndon B. Johnson was elected Vice President, the law was amended so that the Vice President became chairman of the Council, a position subsequently held by Vice Presidents Humphrey and Agnew. The membership was changed to include also the Secretary of State, Secretary of Defense, Secretary of Transportation, NASA Administrator, Chairman of the Atomic Energy Commission. (Public Law 87-26, section 1, April 25, 1961, 75 Stat. 46.)

While the Council was not a strong administrative mechanism, it gave outer space priority status at the top levelof government and its continuing professional staff could keep track of the kinds of information Congress required from the President in an annual report on

(1) a comprehensive description of the programed activities and the accomplishments of all agencies of the United States in the field of aeronautics and space activities and

> (2) an evaluation of such activities and accomplishments in terms of the attainment of, or the failure to attain, the objectives described in section 102 (c) of this Act. (Sec. 206 (a).

These objectives call for the expansion of human knowledge, improvement in aeronautical and space vehicles, the development and operation of vehicles carrying instruments and living organisms through space, long-range studies of potential benefits for peaceful and scientific purposes, U. S. role as a leader, exchange of national defense and nonmilitary information among agencies, cooperation by the United States with nations and groups of nations in peaceful applications, effective use of resources to avoid unnecessary duplication of effort, facilities, and equipment. (Sec. 102, (a) (b) (c)). Other objectives were added in 1976 and 1978 (90 Stat 1260, Sept. 17, 1976; Public Law 95-238, Feb. 25, 1978; NASA Authorization Act of 1979) The later additions are concerned with ground propulsion systems, automobile propulsion, and bioengineering research, development, and demonstration programs. They tend to emphasize the research and development nature of NASA's role.

It must be emphasized that space activities were not divided between the Department of Defense and only NASA, but between the Department of Defense and NASA and numerous other agencies with space and space-related programs; NASA could be termed the center of gravity of this complex except for space communications which early on became the responsibility of the private sector while the Department of Defense cultivated its own space communications system. There was continuous and productive cooperation between the Department of State and NASA on bilateral and multilateral agreements and in space negotiations in the United Nations.

The National Aeronautics and Space Council was abolished by President Nixon in Reorganization Plan No. 1 of 1973 (38 Federal Register 9579, April 18, 1973, 87 Stat. 1089, effective July 1, 1973). This action appeared to be part of a general move to reduce the number of organizations in the Executive Office of the President. In the development of space law, as in other matters, there seems to be a perennial shift between centralizing and decentralizing institutions and their management. The need for top-level coordination continued, however, and the problem has not been satisfactorily solved to this day. Coordination cannot be solved by delegating the function to one agency which has no clout over other agencies, or by resorting to inter-agency committees which meet intermittently with differing personnel on specially selected subjects, or by including space activities as one among many scientific and technological objectives without adequate professional staff and budget.

The NASA Act was successful in relating national and international objectives for space activities. The policy calls for "cooperation by the United States with nations and groups of nations in work done pursuant to this Act and in the peaceful applications of the results thereof." (Sec. 102 (c) (7)) To this declaration, Section 205 was written into the Act by the Senate Committee, providing that "The Administration, under the foreign policy guidance of the President, may engage in a program of international cooperation in work done pursuant to this Act,and in the peaceful application of the results thereof, pursuant to agreements made by the President with the advice and consent of the Senate." In signing the bill, President Eisenhower stated that this provision did not preclude "less formal arrangements for cooperation. To construe the section otherwise would raise substantial constitutional questions." (White House Press Release, July 29, 1958). NASA's Office of International Programs has been outstandingly successful, recent testimony revealing that through the years there have been 1000 agreements with 100 countries on joint projects.

The section of the NASA Act on "definitions", however, has created nettlesome situations. At the time the act was passed, and for many years before and since, the role of the government in aeronautics as related to the private sector was clear; the NACA did research and the aviation industry manufactured and operated planes. When this concept was applied to astronautics, however, new and unique elements arose which could not so deftly be placed in separate government/industry compartments. It could not have been foreseen in 1958 that space activities would generate so quickly such a multiplicity of civilian applications. By placing aeronautics and astronautics together, it became difficult to distinguish their differences as space products developed in different ways. Section 103 provides --

> (1) the term 'aeronautical and space activities' means (A) research into, and the solution of, problems of flight within and outside the earth's atmosphere, (B) the development, construction, testing, and operation for research purposes of aeronautical and space vehicles, and (C) such other activities as may be required for the exploration of space; and
>
> (2) the term 'aeronautical and space vehicles' means aircraft, missiles, satellites, and other space vehicles, manned and unmanned, together with related equipment, devises, components, and parts.

While the definitions still seem to apply without difficulty to NASA's activities in aeronautics, they do not provide pragmatic solutions to all space applications, some of which are essential to maintaining U. S. leadership in space as required by the NASA Act. When some space activities go beyond the research and development stage and have the capability to become operational, there are problems which can delay progress by delaying decisions. This is particularly true of space applications used both by the government and the private sector.

A restrictive interpretation has been made of NASA's role in astronautics as being only that of a research institution which must turn its product over to another agency and/or the private sector after the R&D stage. This assumption was practicable in the early days of the space program when space communications could be turned over to a stronge existing communications industry and when there was a government agency performing the historic function of weather prediction and ready to add space technology. But it has not been a formula applicable to solving problems of establishing an operational remote sensing satellite system; indeed, adherence to a strict research and development role for NASA has been one of the factors which has delayed for years decisions on an operational LANDSAT program, one which requires new legal norms to govern the relationship between government and industry.

B. The Communications Satellite Act of 1962, as amended (76 Stat. 419). This act provides for the establishment, ownership, operation, and regulation of a commercial communications satellite system. The Communications Satellite Corporation (COMSAT) was created, the relationship between government and the communications industry was worked out, and the act recognized the interrelations between national and international influences. It was the second act passed to establish an institution specifically designed for a space application; the NASA Act was general in its application while the COMSAT Act dealt foresightedly with what has become an economically successful enterprise providing a variety of communications services. Legal problems arising from using outer space for communications on the Earth have become a unique specialty in the legal profession. The act was unusual in providing in Section 102 the basis for international cooperation:

> (a) The Congress hereby declares that it is the policy of the United States to establish, in conjunction and in cooperation with other countries, as expeditiously as practicable a commercial communications satellite system, as part of an improved global communications network, which will be responsive to public needs and national objectives, which will serve the communication needs of the United States and other countries, and which will contribute to world peace and understanding.
>
> (b) The new and expanded telecommunication services are to be made available as promptly as possible and are to be extended to provide global coverage at the earliest practicable date. In effectuating this program, care and attention will be directed toward providing such services to economically less developed countries and areas as well as those more highly developed, toward efficient and economical use of the electromagnetic frequency spectrum, and toward the reflection of the benefits of this new technology in both quality of services and charges for such services.

Creation of the COMSAT Corporation provided an effective means whereby the United States could play its role in INTELSAT. The COMSAT Act was amended on November 1, 1978 (92 Stat. 2392) to provide for the establishment, ownership, operation, and governmental oversight and regulation of international maritime satellite telecommunications services. There was a clear national authority for arrangements made by the United States to participate in the International Maritime Satellite Organization (INMARSAT).

C. National Science and Technology Policy, Organization, and Priorities Act of 1976 (42 USC 6601). This was the third major law establishing policy and institutions which affect the conduct of U. S. space activities. In this act, the Congress recognized "the profound impact of science and technology on society, and the interrelations of scientific, technological, economic, social, political, and institutional factors." (Sec. 101 (a)). Among the priority goals to which science and technology should contribute is "advancing the exploration and peaceful uses of outer space." (Sec. 101 (a) (13)). This act created the Office of Science and Technology Policy with a director whose functions are to provide "within the Executive Office of the President, advice on the scientific, engineering, and technological aspects of issues that require attention at the highest levels of Government." (Sec. 204 (a)). Outer space thus became one among all elements perceived in a total context of science and technology, although many of the other twelve objectives could be better attained by using space applications. The institutional elements of the OSTP are still undergoing changes, partly because of a reorganization plan and partly because of policy reviews of the Reagan Administration. This particular act, however, was part of diminishing the priority originally accorded to civilian space activities and had its counterpart in the Legislative Branch.

The House Committee on Science and Astronautics, whose subcommittees had concentrated mainly on outer space, became the Committee on Science and Technology whose jurisdiction includes space among other scientific and technological subjects. The Senate Committee on Aeronautical and Space Sciences was abolished and its functions transferred to the Committee on Commerce, Science and Transportation where NASA's annual authorization of funds is handled by the Subcommittee on Science, Technology and Space which also handles the budget of NOAA in the Department of Commerce. Committee jurisdiction over communications includes space. Space technology has been applied to so many different activities that the establishment of jurisdiction in major House and Senate committees does not preclude space legislation from becoming the legislative responsibility of additional committees with jurisdiction over other subjects, e. g., Agriculture, Interior, and particularly Armed Services. The legislative scene reflects the dispersion of outer space matters among many agencies in the Executive Branch.

The implication for the lawyer is that in any given case or program he must pull together the legal situation from many sources as relevant to his particular task. This is especially true of space communications which may pose problems involving the COMSAT Act, executive orders, the Federal Communications Commission, House and Senate hearings from several committees, agreements of the International Telecommunications Satellite Organization, directives in legislation on Armed Services, etc. In all of this it must be kept in mind that space technology has unique characteristics which can permit or surely prohibit a proposed course of action. If a problem can be solved by technological imperatives, legal problems may not be created or, if they exist, they may be mitigated. Difficulties can arise from purely philosophical discussions of concepts such as "the common heritage of all mankind" and "international regime" without regard for technical facts.

## III. INTERNATIONAL SPACE LAW

International space law has been formulated within the United Nations and through bilateral and multilateral treaties and agreements. The motivation for all treaties has been to ensure that outer space be used for peaceful purposes for mankind's benefit and prevent the new environment from becoming an area for national rivalries and warfare. Some writers have neglected national legislation, considering that space law consists only of the six treaties negotiated within the United Nations. They have often omitted space agreements entered into by two or more nations. Conclusions from such a partial approach cannot be relied upon in understanding and complying with legal norms for the conduct of space activities. The purpose of this paper is, first, to outline the UN-formulated treaties and, second, to set forth the main conventions and agreements reached outside the United Nations. Since the United States alone has had 1000 agreements with 100 nations, their coverage must be the subject of some future paper.

### A. Treaties Formulated Within the United Nations.

1. Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water. This Treaty, which was ratified by the United States on October 7, 1963, entered into force on Oct. 10, 1963. (TS 993, 59 Stat. 1052). It provides in Article I that --

> 1. Each of the Parties to this Treaty undertakes to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, at any place under its jurisdiction or control:
>
> (a) in the atmosphere, beyond its limits, including outer space; or underwater, including territorial waters or high seas; ...
>
> 2. Each of the Parties to this Treaty undertakes furthermore to refrain from causing, encouraging, or in any way participating

> in, the carrying out of any nuclear weapon test explosion, or any other nuclear explosion, anywhere which would take place in any of the environments described, or have the effect referred to, in paragraph 1 of this Article.

This treaty is of unlimited duration and has been ratified by many nations, including the USSR. It should be pointed out that although a treaty may be formulated within the United Nations and recommended by the General Assembly, it should not be referred to as a UN treaty -- it is open for signature and ratification or accession in the same manner as a treaty proposed by any method.

2. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies entered into force on October 10, 1967. (18 U.S.T. 2410, T.I.A.S. 6347, 610 U.N.T.S.205). Several General Assembly resolutions beginning in 1958, laid the foundation for provisions adopted in this treaty. An Ad hoc Committee on the Peaceful Uses of Outer Space was established by General Assembly Resolution 1348 (XIII) December 13, 1958 and requested to report on various aspects of international cooperation including "the nature of legal problems which may arise in carrying out a program to explore outer space." On December 12, 1959, the General Assembly created the permanent UN Committee on the Peaceful Uses of Outer Space (Resolution 1472 (XIV) with 24 members, a number which has since grown to 53. The text of Resolution 1721 (XIV) of December 20, 1961 recognised that international law, including the UN Charter, applies to outer space and celestial bodies and that "Outer space and celestial bodies are free for exploration and use by all States in conformity with international law and are not subject to national appropriation." In a resolution passed on December 19, 1962 (1802, XVII) the General Assembly noted with regret that the Committee on the Peaceful Uses of Outer Space (COPUOS) had not yet made recommendations on legal questions connected with the peaceful uses of outer space. By the following year, however, two resolutions achieved consensus. On December 13, 1963 UN Resolution 1962 (XVIII) made a Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space. On the same day Resolution 1963 (XVIII) on International Cooperation in the Peaceful Uses of Outer Space was passed with a recommendation that "consideration should be given to incorporating in international agreement form, in the future as appropriate, legal principles governing the activities of the States in the exploration and use of outer space."

It had been agreed that COPUOS and its two subcommittees -- the Scientific and Technical Subcommittee, and the Legal Subcommittee -- should try to reach agreement by consensus, i. e., without voting; if voting was required, however, the decision would be made by majority vote. All the space treaties thus far negotiated have been formulated by consensus. While the process is often time-consuming, the unanimity represented by lack of a single objection to a principle results in strengthening the base for international compliance. ("Consensus Decisionmaking by the United Nations Committee on the Peaceful Uses of Outer Space" by Eilene Galloway. Journal of Space Law, vol. 7, Spring 1979, No. 1, School of Law, University of Mississippi 38677).

The principles which were formulated, first in UN resolutions and finally in the draft treaty form, must be regarded as the basic charter of international space law. If situations arise which are not adequately covered by the Treaty's guiding principles, the plan (which has been followed) is to add new treaties in harmony with, and specified in more detail, the required legal norms. This method has proved successful as distinguished from that followed by the law of the sea negotiations where a composite text incorporated the details of every conceivable subject, thus presenting opportunities for a multitude of objections and lengthening the negotiating process.

The main achievements of the 1967 Treaty on Outer Space are: (1) recognition of the common interest of all mankind in the exploration and use of outer space for peaceful purposes; (2) such activities shall be carried out in the interest of all countries and outer space, the moon and other celestial bodies are free for exploration and use by all States; (3) States "undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner;" (4) all States shall use the moon and other celestial bodies "exclusively for peaceful purposes;" (5) astronauts are to be regarded as envoys of all mankind; (6) States shall be internationally responsible for national activities in space; (7) States retain jurisdiction and control over their launched space objects; (8) cooperation and mutual assistance must guide nations engaged in space activities and harmful influences must be avoided; (9) the UN Secretary General is to be informed of space activities; (10) stations on the moon and other celestial bodies are to be open to other States on a basis of reciprocity; (11) of all the provisions, the most significant is Article II:

> Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

Although the United States and the USSR had a monopoly on space technology during the time this treaty was negotiated, nevertheless the guidelines were based on international cooperation by all nations and the prohibition against sovereign claims.

Through the years there have been hundreds of articles analyzing this treaty's provisions. The negative papers are usually based on complaints that the treaty does not go far enough in solving certain problems. The representatives of some nations seem to think that unless they have the capability of launching satellites they do not have equal access, even though this problem is technological and economic and has been met by U. S. and Soviet Union policies to launch satellites for other nations. Launching capabilities have been developed by several other nations, but considering the technical requirements for order in outer space, is it likely that there should be the kind of emphasis on the idea of equity that would result in 150 or more launching centers? Some writers hailed Article IV with its prohibition against nuclear weapons while others have objected that it covers only weapons of mass destruction and should be expanded to include all weapons. (See issues of the Space Law Journal, University of Mississippi and volumes of the annual Proceedings of the International Institute of Space Law published by the American Institute of Aeronautics and Astronautics, 1290 Avenue of the Americas, New York, N.Y.10104).

Following the plan of dealing with specific problems in future treaties, COPUOS successfully reached consensus on another matter on its agenda --

3. Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space. (19 U.S.T. 7570, T.I.A.S.6599, 672 U.N.T.S.119).This treaty, which entered into force on December 3, 1968, was developed from Article V of the 1967 Treaty on Outer Space which dealt with assistance to astronauts in the event of accident, distress or an emergency landing. The details of notifying authorities about astronauts in distress and rendering assistance are defined for all foreseeable circumstances. Article 5 is of particular interest because it covers not only a space object but "its component parts", setting forth conditions for their return to the launching authority which is to incur expenses for the return. Launching authority is defined as the State that launches the spacecraft or an international intergovernmental organization if it has accepted the rights and obligations of the Agreement. There had been sufficient experience with satellites to realize that if some untoward circumstance caused them to descend to Earth, they might not be intact, which turned out to be the case when the Soviet Union's Cosmos 954 re-entered the atmosphere and scattered radioactive debris over northwest Canada. This provision underscores the necessity for a thorough technological factual background as the basis for any legal proposal.

4. The Convention on International Liability for Damage Caused by Space Objects entered into force on October 9, 1973. (24 U.S.T. 2389, T.I.A.S. 7762, U.N.GAOR, 26th Sess., Supp. No. 29;A/8429) This treaty developed from general principles in Article VI and

Article VII of the 1967 Treaty on Outer Space dealing with the international responsibility of States for their national activities as well as liability for damage to another State Party to the Treaty or to its natural or juridical persons. Article VII includes liability caused by a space object or its component parts and covers the Earth, air space and outer space, including the Moon and other Celestial bodies. This provision is in line with the technological facts whereby a spacecraft is launched from the earth through airspace into outer space and can be brought back to Earth. It is the basis of the functional approach to space activities, in addition to concepts dealing with outer space as an area, and is essential to the provision that launching States retain jurisdiction and ownership over their space vehicles and are responsible for them.

Article I provides that for the purposes of this Convention --

(a) The term "damage" means loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations;

(b) The term "launching" includes attempted launching;

(c) The term "launching State" means:
  (i) A state which launches or procures the launching of a space object;
  (ii) A state from whose territory or facility a space object is launched;

(d) The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof.

The purpose of this Convention, which recalls the 1967 Treaty on Outer Space, is the elaboration of effective international rules and procedures to use in obtaining equitable compensation to victims of damage caused by space objects. It took some years to achieve a consensus on this convention because of the hard core issues involved, but it represented the second successful achievement by the Legal Subcommittee of COPUOS to work out specific rules from general guidelines in the 1967 Treaty on Outer Space. Numerous articles have analyzed this convention, some in praise of the achievement while others criticize the treaty for not going far enough in covering all types of damage.

5. Convention on the Registration of Objects Launched into Outer Space entered into force on September 15, 1976 (28 U.S.T.695, T.I.A.S. 8480, U.N.GAOR, 29th Sess., Supp. No. 31, doc.A/9631). For scientific and technical reasons it is essential to keep track

of space objects in orbit around the Earth as well as those launched into deep space probes. Even before this Convention was concluded by the UN Legal Subcommittee of COPUOS, and approved by the full committee and the General Assembly for recommendation to all States, both the United States and the USSR reported launchings to the United Nations. The United Nations periodically published such information. As other nations developed launching capabilities, it was important that all should be made aware of the necessity for orderly use of outer space.

Article II defines the purpose of the convention:

> 1. When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching State shall inform the Secretary-General of the United Nations of the establishment of such a registry.
>
> 2. Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article, bearing in mind the provisions of article VIII of the Treaty on principles governing the activities of States in the exploration and use of outer space, including the moon and other celestial bodies, and without prejudice to appropriate agreements concluded or to be concluded among the launching States on jurisdiction and control over the space object and over any personnel thereof.
>
> 3. The contents of each registry and the conditions under which it is maintained shall be determined by the State of registry concerned.

Article III provides that:

> 1. The Secretary-General of the United Nations shall maintain a Register in which the information furnished in accordance with article IV shall be recorded.
>
> 2. There shall be full and open access to the information in this Register.

It has become the custom to include a reference to the 1967 Treaty on Outer Space in treaties subsequently formed from its provisions. These treaties are called "conventions" or "agreements" to distinguish them from the original charter guidelines, but they are treaties in every sense. The same States are not always parties to each space treaty which could cause problems of interpretation. Reiterated emphasis on the 1967 Treaty provisions, however, should strengthen them and ensure that proposals developed for future legal norms are in harmony and do not conflict with the basic guidelines for States to use in conducting space activities.

6. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies was opened for signature by the United Nations on December 18, 1979. (U.N. GAOR, 34th Sess., 1979, Supp. No. 20, Doc. 2/34/20). This treaty would become effective when ratified by any five nations, an event which had not occurred by April 1982. The United States and the USSR have not signed this agreement which is different from previous space treaties, having raised a number of objections. The agreement declares that --

> The moon and its natural resources are the common heritage of mankind which finds its expression in the provisions of this Agreement,

and furthermore, that States

> undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible.
>
> 7. The main purposes of the international regime to be established shall include
>
> (a) The orderly and safe development of the natural resources of the moon;
>
> (b) The rational management of those resources;
>
> (c) The expansion of opportunities in the use of those resources;
>
> (d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.

Arguments over this proposed treaty are concerned with the concepts of "the common heritage of all mankind", the establishment of an "international regime" and diverse interpretations of "equitable sharing" of the results from exploiting the moon's natural resources. It is interesting to note that the agreement does not cover outer space itself as an area and neither does it apply to space objects in earth orbit. A total concept of the Moon Agreement cannot be obtained only from its text but must be accompanied by the explanations and interpretations of provisions made by COPUOS at the time it was approved on July 2, 1979. (Report of the UN Committee on the Peaceful Uses of Outer Space, General Assembly 34th session, supplement no. 20, A/34/20, 1979. See also "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies" by Eilene Galloway Senate Committee on Commerce, Science and Transportation, 96th Congress, 2d session. committee print. May 1980. 264 p.);

7. Other Issues on agenda of UN COPUOS and its Legal Subcommittee. It has been some years since a space treaty was concluded by COPUOS, the reason being that on the agenda are some hard core issues which do not contain a sufficient margin for compromise. Difficulties arise from the legal implications of remote sensing of the earth from space because some nations insist upon prior consent before satellites collect and/or disseminate data and information of their sovereign territories; other nations object to this idea which has not prevailed in remote sensing since the beginning of the space age. The second agenda item concerns "consideration of the possibility of supplementing the norms of international law relevant to the use of nuclear power sources in outer space." This is a fairly new proposal which arose from investigations following the crash of the component parts of the USSR's radioactive Cosmos 954 satellite on northwest Canada. This item is being discussed in the context of scientific and technological factors analyzed by the Scientific and Technical Subcommittee, and there can be hope that legal problems can be eventually worked out by consensus.

This cannot be said of the agenda item "Matters relating to the definition and/or delimitation of outer space and outer space activities, bearing in mind, inter alia, questions relating to the geostationary orbit." At first this problem was confined to the question of where airspace ends and outer space begins, a question which was disregarded when the space age began because it could not be settled by scientific or legal definitions and space activities proceeded on the assumption that anything in orbit or beyond is in outer space. When the phrase was added to suggest that space activities should be delimited, the functional approach was mixed up with the geographic area of drawing a line between airspace and outer space and there was the possibility that some peaceful space programs, beneficial to mankind, could be censored. Then there was added the issue of equatorial countries claiming the segment of the geostationary orbit above their territories, without claiming space up to that orbit or on either side of the orbit. This raised sovereign claims which had been prohibited in the 1967 Treaty on Outer Space. There are some UN delegates who wish to separate these issues while others wish to keep them combined, the result being a situation in which consensus cannot be expected. (Report of the UN Committee on the Peaceful Uses of Outer Space. General Assembly, 34tn session, supplement no. 20, A/36/20,1981).

One of the thorniest issues is that of international direct television broadcasting satellites which was taken off the agenda of the Legal Subcommittee and inserted on that of the COPUOS for 1981 and 1982. Although consensus has been reached on the draft text of a number of paragraphs intended to comprise a UN resolution (not a treaty), final agreement could not be reached because of the nettlesome issue of prior consent; some nations, particularly the United States, calling for the free flow of information and ideas while others, e. g., the USSR and some developing countries, insisting on a right to give consent prior to receiving programs. Some nations insist upon receiving the data and information, often before it is disseminated to others. At the 1982 session of the COPUOS (March 22-April 2, 1982) in New York, some delegates said they were seeking a paragraph on "duty and right to consult" about direct television broadcast satellites which was so ambiguous that the wording could be interpreted either pro or con! Consensus did not emerge from this formula.

B. Major Treaties and Agreements Formulated by Nations and and Groups of Nations.

1. International Telecommunication Convention gives the purposes of the International Telecommunication Union (ITU). Space technology enabled some institutions to improve functions they had been performing, notably communications, navigation and weather prediction. All spacecraft require communications to and from outer space and this technical imperative resulted in the development of a major space role for the ITU. The origin of its functions dates back to 1865, and in 1947 it became a specialized agency of the United Nations. Its purposes are effected by treaty and the nations of the world comply with its rules and regulations for otherwise there could be chaos both in terrestrial and space communications; this is a case where technology enforces compliance and a police force is unnecessary. The ITU strengthens international cooperation, allocates the radio frequency spectrum and registration of assignments in order to avoid harmful interferance between different national radio stations. The ITU coordinates efforts to harmonize telecommunications facilities and improve networks. Action was taken to ensure rational use of the radio frequency spectrum and of the geostationary satellite orbit. The orbit, technically required by communications satellites, has been declared by the ITU to be a limited natural resource and that first come first served does not give any nation a right to a permanent slot. Continuing international conferences are planned to deal with these problems having technical, legal, political, economic and cultural aspects. Those

who work in space communications must become thoroughly knowlegeable about the ITU, regional and national organizations: governmental such as the U. S. Federal Communications Commission and the Dept. of Commerce; non-goverrmental, e. g., private sector radio, television, and other types of communications services, and government regulated such as the Communications Satellite Corporation (COMSAT). The major communications system for global coverage is INTELSAT.

2. The International Telecommunications Satellite Organization (INTELSAT) Agreement with Annexes and the Operating Agreement Relating to INTELSAT entered into force on February 12, 1973 pursuant to interim and special arrangements for a global commercial communications system which had been in effect since August 1964. (T.I.A.S. 5646, US U.S.T. 1705). INTELSAT is the outstanding example of an international institution established to perform a function uniquely made feasible by space technology. Several organs make up the structure of INTELSAT: the Assembly of Parties, the meeting of signatories, the Board of Governors, and an executive organ responsible to the Board. The functions of the Secretary General, management services and the settlement of disputes have been worked out in great detail with attention to equity of representation and compensation. The separate agreement on operations recognizes the technical nature of providing worldwide satellite communications and the necessity for providing conditions that ensure efficiency and economy. The INTELSAT agreements offer practical precedents for solving other types of space problems, particularly those concerned with equity. For example, Article 4 of the operating agreement includes this provision:

> (a) Each Signatory shall make contributions to the capital requirements of INTELSAT, as determined by the Board of Governors in accordance with the terms of the Agreement and this Operating Agreement, in proportion to its investment share as determined pursuant to Article 6 of this Operating Agreement and shall receive capital repayment and compensation for use of capital in accordance with the provisions of Article 8 of this Operating Agreement.

This formula for equitable sharing can be used for other space activities; obviously this legal arrangement is not the same as equal sharing. Confusion can result when purely philosophical concepts of equality are not combined with practical technical and economic elements essential for operating space facilities.

3. Communications Satellite Act of 1962, as amended. (76 Stat. 419). This Act created the COMSAT Corporation and made provision for implementing Federal coordination, planning and regulation by the President, NASA and the Federal Communications Commission. The necessity for integrating national and international space communications was recognized.

In Section 102 --

> (a) The Congress hereby declares that it is the policy of the United States to establish, in conjunction and in cooperation with other countries, as expeditiously as practicable a commercial communications satellite system, as part of an improved global communications network, which will be responsibe to public needs and national objectives, which will serve the communication needs of the United States and other countries, and which will contribute to world peace and understanding.
>
> (b) The new and expanded telecommunication services are to be made available as promptly as possible and are to be extended to provide global coverage at the earliest practicable date. In effectuating this program, care and attention will be directed toward providing such services to economically less developed countries and areas as well as those more highly developed, toward efficient and economical use of the electromagnetic frequency spectrum, and toward the reflection of the benefits of this new technology in both quality of services and charges for such services.

This law harmonized with the NASA Act in combining the national and international concepts appropriate for an inherently international technology developed nationally.

4. International Maritime Satellite Telecommunications. On November 1, 1978 the COMSAT Act was amended by Title V -- The International Maritime Satellite Telecommunications Act which enabled the United States to provide for participation in the International Maritime Satellite Organization (INMARSAT) for operation of a global system with facilities to serve the commercial safety needs of the United States and foreign countries (92 Stat. 2392, 47 USC 701,note 47 USC 751 note). This space law provides that U. S. participation in INMARSAT shall be through the COMSAT Corporation which is referred to as "a private entity operating for profit, and which is not an agency or establishment of the Federal Government." The Convention on the International Maritime Satellite Organization, September 3, 1976, is combined with an operating Agreement following the pattern set by INTELSAT. The purpose of INMARSAT is defined in Article 3:

> (1) The purpose of the Organization is to make provision for the space segment necessary for improving maritime communications, thereby assisting in improving distress and safety of life at sea communications, efficiency and management of ships, maritime public correspondence services and radiodetermination capabilities.
>
> (2) The Organization shall seek to serve all areas where there

is need for maritime communications.

(3) The Organization shall act exclusively for peaceful purposes.

From all these institutions for space communications -- the ITU, INTELSAT, COMSAT and INMARSAT, -- we see that when there is a requirement for a specific function to serve national and international purposes, it is possible to work out legal arrangements for representation, management, funding, and operations.

5. INTERSPUTNIK. The Agreement on the Establishment of the "INTERSPUTNIK" International System and Organization of Space Communications was signed in Moscow on November 15, 1971 and has been ratified by Bulgaria, Cuba, Czechoslovakia, the German Democratic Republic, Hungary, Mongolia, Poland, Romania, and the USSR. The Agreement creates institutional arrangements necessary for a space segment of communications satellites and earth stations. (Space Law, Selected Basic Documents, second edition. Senate Committee on Commerce, Science, and Transportation, 95th Congress, 2d session, December 1978: 385-398).

6. The Agreement of the Arab Corporation for Space Communications, July 15, 1976, is one of the examples of the growth of regionalism resulting from space communications technological requirements. Planning for the system was the result of an ITU survey of requirements of the Middle East and Mediterranean regions for services for telecommunications, TV relays, education and direct broadcast satellites. Provision is made for Administration and management, the space sector, ground stations and equipment, and funding and operation of the system. (Space Law, op cit., 449-467).

7. EUTELSAT is an organization first envisaged by the European posts and telecommunications authorities leading to an Agreement on the Constitution of a Provisional Telecommunications Satellite Organization, opened for signature on May 13, 1977 and entering into force on June 30, 1977. After studies by the Conférence Européenne des postes et Télécommunications (CEPT) and the European Space Agency (ESA), it was considered "desirable to establish a provisional organisation pending the working out of the final organisation for operating commercial satellite telecommunications systems including all telecommunications services, established by the European Telecommunications Administrations"and open to all its members. Implementing agreements have been established between this regional institution and ESA. Plans are being explored for setting up a similar institution for space meteorology. (See Institutional Arrangements for Space Cooperation in Europe by M. G. Bourely. Proceedings of the 24th Colloquium on The Law of Outer Space. International Institute of Space Law, Sept., Rome, Italy. American Institute of Aeronautics and Astronautics, 1290 Avenue of the Americas, New York, New York, 12104, 1982:159-167. See also

Space Law, op cit., 469-486.)

8. Convention for the Establishment of a European Space Agency (ESA), signed in Paris on May 30, 1975. Developed from predecessor agencies, the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO), ESA has a legal personality, power to make contracts and can be a party to legal proceedings. It is devoted to many kinds of space programs provided they are for "exclusively peaceful purposes." According to Article II, ESA provides for and promotes cooperation among European states in space research and technology and their applications for scientific purposes and operational systems. The organization, which has a Council, a Director and staff, formulates and recommends space policy, implements activities, coordinates programs and works out "a coherent industrial policy" for its Member States. The convention is noteworthy for its arbitration provisions for the settlement of disputes. Attached to the convention are five annexes of rules and regulations on financial provisions, optional programs, internationalization of national programs, and industrial policy for Member States. There have been continuous contacts and a high degree of cooperation between ESA and NASA. Here, again, we see that space technology produces requirements for regional cooperation within the global context.

## IV. SUMMARY AND CONCLUSIONS

This year marks the 25th anniversary of the beginning of our use and exploration of outer space. During this quarter of a century outer space has been preempted by a variety of peaceful purposes with widespread application, exceeding all forecasts made at the dawn of the space age. There was immediate recognition that space science and technology could be used for peace but had the potential for conflicts that might lead to war, producing the strong motivation for regulating the new environment for mankind's benefit. The history and development of space law is an unusual demonstration of foresight in handling the impact of space science and technology on society. The degree to which rules and regulations were applied to space activities can be measured by recognizing that space treaties have produced a new branch of international law, that many national laws have been passed to regulate the conduct of space activities, and that new institutions have been created to manage national and international space activities while existing organizations have added space functions.

This task was facilitated by several factors: the exploration of outer space began as part of the International Geophysical Year during which scientists and engineers from 67 nations carried on experiments on the world's environments; space technology is international because space vehicles rapidly orbit the Earth without regard for national boundary lines; and space technology requires compliance with the technical conditions essential for its success. This is particularly true of space communications where non-compliance with technical requirements can result in chaos both in terrestrial and outer space communications. Space technology obviates the need for a police force.

If early formulators of space law had insisted upon defining where airspace ends and outer space begins before deciding other issues, we would still be at dead center as this question is still being debated. But they decided to set aside this difficult question, assuming that any spacecraft that goes into orbit or beyond is in outer space. Besides, there were no problems which required for their solution a decision on where outer space begins.

It was foreseen that sovereign claims to outer space, the Moon and other celestial bodies could cause national rivalries and conflicts, and this issue, which had the greatest potential for future disagreements, was handled by prohibiting sovereignty claims in the new space environment. At the same time, nations assumed responsibility for their space vehicles and personnel thereon.

In the 1967 Treaty on Outer Space all States were made free to explore and use outer space without discrimination, ensuring from the beginning that this new frontier was not conceived as a monopoly by the United States and the USSR although they were first to develop space technology.

Emphasizing that space should be used for peaceful purposes for the benefit of all mankind, a provision in the 1958 NASA Act, the 1967 Space Treaty provided that the Moon and other celestial bodies should be used "exclusively for peaceful purposes", although military personnel could be used for scientific research and other peaceful pursuits. The arms control provision, which has been criticized for not going far enough, at least takes a step forward by prohibiting nuclear weapons and other kinds of weapons of mass destruction from being orbited around the Earth, installed on celestial bodies or stationed in outer space.

The method used to formulate space treaties by consensus has been successful as compared to that used for the law of the sea. This is because the 1967 space treaty provided the foundation of guiding principles, and could be supplemented later on as specific situations arose which needed more detailed regulation. In contrast, the law of the sea method was to compile one composite text including so many issues that consensus is difficult to achieve and there is delay in implementing those provisions that have been agreed upon.

It is noteworthy that when a specific need arises, it has been possible to get national legislation and international law to govern the function so that it will be a successful service, e. g., communications, navigation and meteorology. Space technology brought about an increase in patterns of international cooperation not only global but also regional. The technology is peculiarly adaptable to the solution of certain regional problems. There has been a spectacular development of bilateral and multilateral agreements for specific projects, most of them involving the United States.

On the U. S. national front we have seen outer space activities originally given the highest priority with top-level status both in the Executive and Legislative Branches of the government. Institutions and funding were provided for overall continuing attention to the total U. S. space program with methods for evaluation of interacting factors. This priority status was lost in the Executive establishment and the Congress, outer space becoming one among a number of subjects included in the general term of science and technology. As space and space-related programs expanded in the government, enabling an improvement of services, the result was dispersion without provision for continuous professional coordination that could foresightedly recommend possible solutions to emerging problems, e. g., government regulation of nongovernmental space activities.

There are some lessons for the lawyer when contemplating the history and development of space law. All space activities are multidisciplinary and in any given case it is necessary to acquire a knowledge of all the facts: scientific, technological, political, economic, and cultural, as a basis for dealing with legal implications. There is no one place in the government where all this information is available and therefore it is necessary to check with numerous agencies, laws, hearings, and Congressional reports. Above all, it is necessary to realize that space activities take place on the Earth -- the people, funding, manufacture and operation of hardware, receipt of data and information and its application to the solution of problems and provision of services -- all such activities are Earth-oriented and raise a variety of legal problems, international and national, state and local. It is from this complex foundation that the lawyer is obliged to consider litigation in space law.

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# CONSENSUS DECISIONMAKING BY THE UNITED NATIONS COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE

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## I. *Introduction*

The use of consensus as a method for decisionmaking by the United Nations Committee on the Peaceful Uses of Outer Space has proved remarkably successful in bringing about legal agreements for international space cooperation. The high degree of achievement, demonstrated in the drafting of four space treaties which have been ratified by many nations, raises the question—especially in the minds of those who seek international cooperation in other areas—of the reasons why decisions by concensus have been attainable.

## II. *What is Consensus?*

Consensus is one method whereby a group reaches a decision. It is not the only way of coming to agreement on an issue or a course of action and, indeed, is somewhat unique as compared to various types of voting. Decisions by voting may require qualified voters to pass measures by a majority, two-thirds, three-fourths, or unanimous vote and each method may be appropriate for the situation in which it is used. The degree of required positive action depends upon advance determination by a group of those situations which range from minimum to maximum requirements for broad-based support. At one end of the scale is majority voting to decide matters which the whole group is willing to accept by that procedure; at the other end of the scale is unanimous voting which may be required in situations identified as so important that the possible non-compliance of one member can jeopardize the attainment of a goal considered essential for the whole membership. Unanimous voting can also take the form of acclamation when such favorable attitudes have been formed prior to voting that they evoke sudden decisions.

The next question concerns the difference between consensus and unanimous voting. There is no difference in the result which produces a legal document, agreement on undertaking a program, appropriating funds, etc. The difference between consensus and unanimous voting lies in the process used to achieve the end result; consensus is achieved without voting whereas voting is required for a unanimous record. The process of consensus can set in motion certain positive attitudes which carry over beyond the agreement and tend to facilitate implementation of formal agreements. This is because consensus is achieved by patient negotiation in reconciling different viewpoints until reaching a point where no member objects to the result. Although the consensus process has been successfully followed by the United Nations Committee on the Peaceful Uses of Outer Space, it was not explicitly defined. The "no objection procedure" is used whereby the chairman, sensing that agreement has taken substantial form, states "*if* there is no objection, it is so decided."

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The United Nations Juridical Yearbook 1974 includes an analysis of the "Use of the Term 'Consensus' in United Nations Practice" in connection with a meeting of the Population Commission:

> The Director of the General Legal Division, Office of Legal Affairs, stated that no plenipotentiary conference under United Nations auspices had included in its rules of procedure a provision on consensus, partly due to the fact that it was somewhat difficult to arrive at an exact definition of consensus, and partly because the objective which was usually sought, namely, that every effort should be made to achieve a consensus before a vote was taken, could better be achieved by simply an understanding at the beginning of the conference. In United Nations organs, the term 'consensus' was used to describe a practice under which every effort is made to achieve unanimous agreement; but if that could not be done, those dissenting from the general trend were prepared simply to make their position or reservations known and placed on the record.[1]

The Council of the World Population Conference 1974 approved provisional rules of procedure and the annex on consensus recommended by the Population Commission states "that it is highly desirable for the World Population Conference, 1974, to reach decisions on the basis of consensus, which is understood to mean, according to United Nations practice, general agreement without vote, but not necessarily unanimity."[2]

The Director of the General Legal Division pointed out that the Third Conference on the Law of the Sea has rules on requirements for voting including a provision whereby taking a vote on a substantive question can be deferred for a period of time during which the President "'shall make every effort, with the assistance as appropriate of the General Committee, to facilitate the achievement of general agreement . . ." If "all efforts at reaching general agreement have been exhausted," the voting procedures adopted by the Conference can be followed.[3]

The Conference on Security and Cooperation in Europe, whose Final Act was signed in Helsinki on August 1, 1975, includes a definition of consensus in its Rules of Procedure—

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[1] U. N. Jurid. Yb. 163-164 (1974).

[2] *Id.* at 164.

[3] *Ibid.*

> Decisions of the Conference shall be taken by consensus. Consensus shall be understood to mean the absence of any objection expressed by a Representative and submitted by him as constituting an obstacle to the taking of the decision in question.[4]

It is evident that consensus is a highly desirable way of achieving international accord because (1) the process of seeking agreement continues with patience and is not cut off suddenly by a vote which may defeat what might have come to fruition had more time been taken with the give and take process of consensus; (2) the situation may be such that a majority vote could not result in the "adoption" of a course of action, particularly if implementation of the decision, in terms of funding, personnel, and technological expertise, depended upon nations which had voted against the measure; and (3) group solidarity in decisionmaking ensures maximum compliance in establishing and maintaining an activity of general benefit. There is also a positive psychological effect when members of a group feel together with sympathy for differing viewpoints, motivated by a desire to bring about harmony in their collective judgment. If a member has not objected, a proposal can be adopted but this unspoken consent should not be interpreted as negativism; there is a positive willingness to settle the issue in question.

Before analyzing the reasons why the United Nations Committee on the Peaceful Uses of Outer Space has succeeded in negotiating four space treaties by consensus, it is necessary to recall the historical background of adopting this rule of procedure.

## III. *Adoption of Decisionmaking Procedure by the United Nations Committee on the Peaceful Uses of Outer Space*

On December 12, 1959, the General Assembly adopted resolution 1472 (XIV) creating the permanent United Nations Committee on the Peaceful Uses of Outer Space which followed the Ad Hoc Committee created on Dec. 13, 1958 by resolution 1348 (XIII).[5] Although there was general agreement among the 24- member Committee on some of the most critical issues—the common interest of mankind in the peaceful uses and exploration of outer space, the avoidance of national rivalries, and emphasis on international cooperation—nevertheless, there were three questions which were not resolved for almost two years and the Committee met only once, on November 27, 1961, when little more than a month remained in the two-year terms of the appointed members. The issues which impeded progress in the Committee's work were unanimous versus majority voting, the designation of officers of the Committee, and the international scientific conferences.[6] It is apparent from discussions reported in United Nations documents that unanimous voting was associated with the right to veto which was objectionable to many nations, whereas achievement of agreement by consensus was a non-voting method of procedure. This difference may seem more subtle in theory than in practice. In practice, the main difference is that the process of achieving a consensus can continue so that discussion and negotiation are not ended abruptly by a vote which may produce a negative result no member really wants. Also, in the case of the uses and exploration of outer space, there were originally only two nations with advanced space technology, the United States and the USSR, and even majority voting by non-space countries could not become the deciding factor in the development of national space programs. The difficulty of working out a decisionmaking procedure was expressed by Mr. Demetropoulos of Greece who analyzed the situation as follows:

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[4] Conference on Security and Cooperation in Europe. Final Act. 6. Rules of Procedure (69) 4 (August 1, 1975).

[5] A history of the Ad Hoc Committee on the Peaceful Uses of Outer Space and events leading up to the creation of the permanent Committee will be found in "International Cooperation and Organization for Outer Space" by Eilene Galloway. Staff Report Prepared for the Senate Committee on Aeronautical and Space Sciences, Doc. No. 46, 89th Cong., 1st Sess. 183-193 (1965).

> Unanimity is certainly something that one should hope for, and delegations make laudable efforts to reach unanimity by private talks, amendments, compromise, avoiding a vote on important resolutions before an acceptable formula has been found. But to require unanimity a priori would impede the work of the Committee and the possibility of any progress. The principle of unanimity goes against the principle of equality, since one State could have greater importance than all the others.[7]

After considerable discussion and negotiation, a draft resolution was sponsored by the 24 member nations on "International Cooperation in the Peaceful Uses of Outer Space"[8] and U. S. Ambassador Adlai E. Stevenson said that the new proposal represented the best thinking on ways to achieve cooperation of benefit to all nations and that—

> We look forward to constructive discussions of these proposals—and to improvement upon them. They do not represent fixed positions. We are prepared to consider constructive suggestions from any member of the committee so that the widest possible measure of common agreement may be reached.[9]

The membership of the Committee was expanded from the original 24 agreed to by the General Assembly on December 12, 1959, to 28 nations on December 20, 1961, and a compromise was reached on the issue of voting. The agreement was that the Committee would try to reach agreement by consensus, *i.e.*, without voting, but if voting is required the decision would be made by majority voting. Mr. Plimsoll of Australia summarized the situation—

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[6] U. N. Doc. A/C.1/PV. 1213 at 41-42 (December 7, 1961).

[7] *Op. cit. supra* note 5 at 198.

[8] U. N. Doc. A/C.1/L.301/Rev. 1 (Dec. 11, 1961). See also Docs. A/4987; A/C.1/857 (21) on Report of the Committee on the Peaceful Uses of Outer Space.

[9] U. N. Doc. A/C.1/PV.1210 at 6 (Dec. 4, 1961). See also Dept. State Bull. 180-186 (Jan. 29, 1962).

> . . . There were discussions over a period of 2 years between the Soviet Union and the United States, each of them from time to time consulting other countries on the Committee so that they could not be regarded as speaking only for themselves but rather each of them speaking for a number of countries. In the end the final position of the United States, before the General Assembly met, was the following one. It was a position that was adopted after consultation with many countries, including Australia. Therefore, it is the position of the Australian Government also.
>
> The position was that there should be statements made at the Committee on the Peaceful Uses of Outer Space by any countries which wish to make them, including no doubt the Soviet Union and the United States, but possibly others, on the principles of voting relating to the Committee, and at the end of it the Chairman of the Committee would make the following statement, agreed in advance with all members. The Chairman of the Committee would say this: "If there is no objection, the Committee takes into account the statements which have just been made by the delegations of the United States and the Union of Soviet Socialist Republics. While there can be no question but that this Committee is governed by appropriate rules of the General Assembly, I interpret what has been said to mean that it will be the aim of the members to conduct the Committee's work in such a way that the Committee will be able to reach agreement in its work without need of voting. . . ."[10]

Agreement on the consensus procedure made it possible for the General Assembly to adopt by unanimous vote resolution 1721 (XVI) on December 20, 1961, a resolution which contains many of the principles which were later included in space treaties.

During the spring of 1962, the Committee on the Peaceful Uses of Outer Space began its practice of using consensus as the method for making decisions. On March 19, 1962, the Chairman, Dr. Franz Matsch (Austria) announced that—

> In the first place, I should like to place on record that through informal consultations, it has been agreed among the members of the Committee that it will be the aim of all members of the Committee and its subcommittees to conduct the Committee's work in such a way that the Committee will be able to reach agreement in its work without need for voting.[11]

## IV. *Significance of Space Treaties*

Outer space was added to land, sea, and air as a fourth environment of the world. Space science and technology which brought about this development are inherently international dynamic forces applicable to a great variety of activities. Global systems of space communications and meteorology, progress in navigation and mapping, monitoring of air, land and sea pollution to improve the quality of the Earth's total environment, these are but a few of the peaceful purposes which can benefit all mankind. At the same time, there was early recognition that outer space could become an arena for warfare and fear of this possibility produced the strong and universal motivation to prevent outer space from being used for armed conflict.

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[10] U. N. Doc. A/C.1/PV.1211 at 26-27 (Dec. 5, 1961).

[11] U. N. Doc. A/AC.105/OR.2. at 5 (Mar. 19, 1962). See also U. N. Doc. A/5181 at 3-4 (Sept. 27, 1962).

The method used to ensure that outer space be used for peace and not for war was the creation of international space law. Patterns of international cooperation developed in accordance with bilateral and multilateral agreements and the texts of space treaties were drafted by consensus among the members of the United Nations Committee on the Peaceful Uses of Outer Space. Instead of the two original space powers, the United States and the USSR, seeking to monopolize the development of space activities, agreement was achieved on international cooperation and participation of all nations.

The use of consensus in the United Nations negotiation of the texts of space treaties did not result in adoption of the least common denominator on which agreement could be reached; that is, on insignificant matters of low-level concern. Instead, we find that the most important issues have been decided and made a part of international law. The outstanding results of the agreements reached by consensus contradicts those who alleged that this type of unanimous support could only be achieved on minor points.

Between 1967 and 1976 four space treaties have come into force, and in each case the consensus method was used by the Legal Subcommittee of the UN Committee on the Peaceful Uses of Outer Space in formulating agreed texts and bringing about this body of space law. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies entered into force on October 10, 1967.[12] On December 3, 1968 there was entry into force of the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space.[13] The Convention on International Liability for Damage Caused by Space Objects of October 9, 1973[14] represents one of the most important international agreements whose detailed provisions are designed to avoid difficulties which could arise in connection with space activities. On this Convention four delegations—Canada, Iran, Japan and Sweden—reserved their positions on the substance of the text because it omitted proposals they favored for full compensation and binding decision of the Claims Commission. Their reservations did not constitute an objection to forwarding the text to the General Assembly but they reiterated their positions in the First Committee and abstained from the General

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[12] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, January 27, 1967, [1967] 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205 (effective Oct. 10, 1967).

[13] The Convention on International Liability for Damage Caused by Space Objects, March 29, 1972, [1973] 24 U.S.T. 2389, T.I.A.S. No. 7762 (effective Oct. 9, 1973).

[14] The Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, April 22, 1968, entered into force for the United States on December 3, 1968; [1968] 19 U.S.T. 7570, T.I.A.S. No. 6599, 672 U.N.T.S. 119.

Assembly vote.[15] Later, however, Iran ratified the Convention and accessions were deposited by Canada and Sweden.[16] This episode strengthened the use of consensus as a method of international cooperation, patience and consideration being exercised rather than resort to procedures which could obstruct attainment of some desired objectives.

The process of international cooperation was furthered by the Convention on Registration of Objects Launched into Outer Space which entered into force on September 15, 1976.[17]

These treaties are not the only component parts of international space law which also includes international law, the United Nations Charter, the Nuclear Test Ban Treaty of October 10, 1963 and innumerable bilateral and multilateral agreements made by the National Aeronautics and Space Administration in accordance with the National Aeronautics and Space Act of 1958. Space law also includes agreements by the European Space Agency, applicable rules and regulations of the International Telecommunication Union (ITU), legal agreements establishing the International Telecommunications Satellite Organization (INTELSAT), INTERSPUTNIK, etc.

Although the use of consensus as a decisionmaking mechanism is advantageous and has proved successful when applied to several complicated subjects, it cannot be expected that this method, in and of itself alone, will automatically produce conclusive results in all cases.

## V. *Reasons for Difficulty in Attaining a Consensus*

It takes time to reconcile differing viewpoints expressed on issues involved in any problem. The amount of time depends upon a variety of factors: the urgency for decision generated by perceived dangers which must be avoided at all costs; political and economic factors which may be linked to other problems and thus cause delays; irreconcilable elements combined with a sense that the subject has not ripened for final disposition; the frequency with which decisionmaking bodies meet; and the lack of an institutional structure with authority to make final decisions.

For some years there have been several subjects pending before the Legal Subcommittee. Lack of agreement has caused these items to be put forward on the agenda for each successive year, and this was true even before the Committee's membership was increased from 37 to 47 beginning with 1978 sessions. Admitedly, it is more difficult to get agreement from a larger than a smaller group, but the Moon Treaty text had been discussed for seven years prior to the enlargement of the Committee on the Peaceful Uses of Outer Space. Generally speaking, each item on the agenda of the Legal Subcommittee has become a problem with such basically divergent elements that the task of reconciling the differences is difficult and time-consuming. Nevertheless, in each case there are areas of agreement which provide momentum for continuing discussion.

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[15] *Ibid.*, U. N. Gen. Ass. 26th Sess., Supp. 20, Doc. A/8420/1971, para. 35. Report of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space. Doc. A/AC.105/94, para. 24 (July 8, 1971).

[16] Space Law: Selected Basic Documents, Sen. Comm. on Commerce, Science, and Transportation, 95th Cong. 2nd Session 67-68 (2nd ed., 1978)

[17] The Convention on Registration of Objects Launched into Outer Space, was signed on January 14, 1975 and entered into force on September 15, 1976; T.I.A.S. No. 8480.

The formulation of four international legal instruments, by direction of the General Assembly, has occupied the attention of the Legal Subcommittee for some years without resulting in a consensus.

*First,* the text of the draft treaty on the Moon and other celestial bodies comprises many points of agreement but the major unresolved issue concerns the use and exploitation of the Moon's natural resources. Is the Moon to be declared the common heritage of all mankind and, if so, what type of international regime should apply? And exactly what specifically is meant by "regime"?

*Second,* the direct television broadcasting by satellite is another item assigned as a high priority by the General Assembly and the proposed principles to govern this activity include some issues which have thus far proved irreconcilable. Although there are agreed provisions, the main undecided questions are whether or not a broadcasting nation must obtain the consent of other nations prior to broadcasting; and whether or not each receiving nation shall exercise control over the content of programs.

*Third,* the Legal Subcommittee is also required by the General Assembly to give high priority to the legal implications of remote sensing of the Earth from outer space in order to formulate draft principles. The result thus far has been a draft text with numerous square brackets around disagreed points. The major issue is whether or not a sensed State's prior consent must be obtained by a State which conducts remote sensing. Furthermore, there are States which wish to control the dissemination of data and information about their resources, particularly before such information is given to third parties.

*Fourth,* agreement is being sought on the definition and/or delimitation of outer space and outer space activities including questions relating to the geostationary orbit. Although the distinction between airspace and outer space has been of interest to several nations, and fascinating to individuals, since the beginning of the space age, it has not been discussed as fully as the three problems previously mentioned because the Legal Subcommittee lacked time. Further, lack of a definition has not impeded progress in space science and technology and its applications to beneficial uses, particularly communications and meteorology. In the last two years, however, increased interest has developed concerning a definition of outer space, but a move toward attaining a consensus is not in the same advanced stage of development as in the cases of draft texts relating to the Moon, direct television broadcast satellites, and remote sensing of the

Earth from outer space. The definition of outer space has been discussed sufficiently, however, so that at least one irreconcilable element has been identified: the claim by equatorial countries that the segment of the geostationary orbit over their territory is subject to their sovereignty rather than being in outer space as provided in the 1967 Treaty on Outer Space.

The conclusions which may be drawn from experience with negotiations on unresolved issues before the Legal Subcommittee are that (1) issues require different amounts of time to resolve; (2) when positions are taken on the basis of different political systems, the conflicting assumptions are more difficult to reconcile in an agreed text; (3) while it is more difficult to get agreement in a large committee, a difficulty that increases with size, the increase in the Committee's membership from 37 to 47 is not the basic cause of lack of consensus on the pending issues; (4) when divergent views are rooted in different political and cultural philosophies, lack of agreement cannot be blamed on the *method* of reaching that agreement whether it is by unanimous voting, majority voting, or consensus. It is the *substance* of the goal that is at stake and not the parliamentary mechanism by which the destination is to be reached.[18]

## VI. *Reasons for Success of the Consensus Method by the United Nations Committee on the Peaceful Uses of Outer Space*

The Committee on the Peaceful Uses of Outer Space was the first United Nations body to decide to use consensus as the procedure for its work. An analysis of the reasons why the Committee, its Legal Subcommittee and the Scientific and Technical Subcommittee, have been successful in using this method to formulate four space treaties, now ratified by many States, should prove helpful to other United Nations organizations working on complicated subjects. The analysis should also sustain the Committee in the wisdom of its choice.

*First,* there was at the beginning of the space age a strong and prevailing motivation for international cooperation and agreement because of the realization that space science and technology could be used for peace and war. To promote peaceful purposes and avoid hostile conflicts was an objective which unified those who were responsible for planning guidelines for the future. So strong was the motive to use outer space for the benefit of all mankind that claims of sovereignty, the most critical of issues, could be prohibited by treaty.

*Second,* the nature of space science and technology contributed to emphasis on peaceful uses, not only because of the wide variety of space applications but also because satellites encircled the Earth every 90 minutes in orbits which disregarded national boundaries and emphasized the necessity for international space cooperation.

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[18] Report of the Committee on the Peaceful Uses of Outer Space. General Assembly, 32nd session, supplement No. 20, Doc. A/32/20 (1977). See also the Committee's report for the 33rd session, supplement No. 20, Doc. A/33/20 (1978) and Reports of the Legal Subcommittee: Docs. A/AC.105/196 (April 11, 1977) and A/AC.105/218 (April 13, 1978).

*Third*, the problems which could be identified as likely to arise in the future were multidisciplinary and involved the integrated analysis of many factors: scientific, technological political, economic, legal and cultural. It takes time to figure out how best to handle such problems and the process of consensus is attuned to time-consuming analysis. If foresight is to result in a prudent course of action, each element of a problem must be weighed and evaluated with regard to the probable consequences of different options. Sometimes technical or economic factors are weightiest in settling an issue; in other circumstances, political or legal factors may become paramount. Even though all the considerations which go into making a decision are time-consuming, it is noteworthy that the Committee on the Peaceful Uses of Outer Space negotiated by consensus four complicated space treaties which came into force in less than ten years.

*Fourth*, the chairman of the Committee, as well as the chairmen of the two subcommittees, play a key role in the consensus process. The chairman must be sensitive to the group psychology in sensing when a subject is ripe for agreement, feeling that there is not likely to be an objection, and at exactly the right moment being able to say "If there is no objection, it is so decided." The chairman must not be dictatorial in forcing his own position on the group, but must gain the respect of all Members in recognizing his objectivity in perceiving varying viewpoints. The Committee on the Peaceful Uses of Outer Space has been outstandingly successful in the chairmen who have presided over the full Committee, the Legal Subcommittee and the Scientific and Technical Subcommittee. Much of the successful use of the consensus procedure is due to the outstanding abilities of the distinguished chairmen.

*Fifth*, for the longest period of its history, the Committee's membership has been small enough to be viable and facilitate personal contacts and negotiation. There is a point beyond which expansion of membership would undoubtedly delay the process of achieving agreement and could even be completely counter-productive.

*Sixth*, achieving agreement by consensus requires give and take in negotiations. When issues are presented with sufficient margins to allow for developing a common ground, the time of negotiation is shortened. Irreconcilable elements which are sharply drawn can result in unyielding positions which frustrate the achievement of collective group judgment. There are many examples in the history of the Committee on the Peaceful Uses of Outer Space of proposals which were originally far apart but, gradually, differences were narrowed so that ultimately the group could make a collective judgment.

*Seventh*, some methods have been developed to facilitate the consensus procedure. The Committee, as well as its subcommittees, establish working groups for informal discussions of perplexing matters. The working groups may set up mini-working groups for even more informal consideration of difficulties in identifying elements of problems or the precise wording likely to produce agreement. The practice of preparing a text which indicates areas of agreement, and sets disagreeing sections in square brackets, is valuable to all Members who then know exactly what remains to be done before the whole question is decided. Such texts also project into the future the assignment of a continuing task which will be considered until a satisfactory conclusion is reached. A certain sense of momentum is created in the group whose members seem psychologically headed toward making a contribution to international cooperation in the peaceful uses of outer space.

# AN HISTORICAL APPROACH TO THE ISSUES SURROUNDING INTERNATIONAL SPACE COOPERATION AND VENTURES

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## Introduction

International Space Conference preparations have previously been approached as a purely technical, international forum in the U.S. It has come to the attention of many, however, that, though perhaps not intended, many of the events in past conferences have been political in nature. This represents a significant shift in the guidelines for U.S. preparations. The ideal negotiator must now bring with him, not only a technical knowledge, but an historical awareness as well. He should be familiar with issues that have come before and that will come up in the future.

It is the attempt of this paper to provide an overview of what has already transpired in international negotiations, with respect to the approaching UNISPACE Conference scheduled for August 9-21, 1982.

## Changing Political Climate

It is important to remember that the technical capability to launch a vehicle into orbit emerged from the military advances of World War II. The Germans were the first to successfully employ the technology of long-range guided rockets. The capability of the V-2 demonstrated their advancement. With the end of the war, most of the leading German rocket scientists and engineers surrendered to the United States, though the Soviets gained technicians as well. The Soviets did, however, acquire much of the practical hardware that was used by the Germans. Combined with a strong tactical rocket program of their own, the Russians moved into long-range ballistic missiles and space. The U.S. soon followed.

Recognition of the Russians as first in space was hard to swallow with the launch of Sputnik I in 1957. (Report: Space Activities, pp.5-6.) Though the U.S. would reach space in the next year, the fear of bombs dropped from orbit has not left this country. This was a technology born of military needs in the midst of the Cold War. For this reason the potential threats were more obvious than the possible benefits. It is not surprising to recall that satellite technology was originally feared in the U.N.

To a large extent the policy of the U.N., since this period, has been one of expansion. Through the International Geophysical Year ('57-'59) and flights by each of the superpowers, world-wide attention was brought to space science. In 1958 the U.N. created an Ad Hoc Committee to deal with such matters. The U.N.'s Twenty Power Draft Resolution embraced the principle of equality of all states in the exploration of outer space. With this came the advent of third world concern over the issue.

Superpower interests first began to emerge during the Kennedy-Khruschev correspondence. This legitimized the role of the U.N. in space policy, since much of its organization was used. Though a degree of competitive animosity still existed between the U.S. and the USSR, a policy of vested interest began to link the two. Much of this may have emerged from the third world itself, as the superpowers were forced to deal with an emerging united front. Issues such as the sovereignty of remote sensing data and geostationary orbit slots divided the developed and underdeveloped world.

With the emergence of the European Space Agency, as well as France, Japan, and other national interests, the picture began to change. The policy positions of countries became somewhat dependent upon the established strategic alliance system. Multilateral arrangements, however, eventually began to give way to international competition.

The Soviet Union's proposal for a "new world order of information" is no longer backed by the U.S., which sees such a policy as imposing a body of possible rules and regulations which would impede freedom of the press and information. (See International Law.) The Soviet treaty banning the deployment of weapons in outer space is seen as directed at the U.S. Space Shuttle. This surfacing at a time when both countries are toying with orbital laser weapons. A slipping back toward cold war diplomacy may be occurring for both countries. (Rich, p. 682.)

U.S.-USSR relations in space are mirrored by overall political relations between the two countries. Perhaps this is due to space policies which have always been in the forefront of each country's political relations. Superpower relations clearly have had a hand in space policy.

The U.N. has become the focal point of scientific and technological developments. U.N. bodies such as the Committee on Peaceful Uses of Outer Space (COPUOS) and its legal, and science and technology subcommittees have gained in importance. This refocusing of power represents a significant change.

## International Cooperation

The first effort towards international cooperation in space activities came in late 1958 with the creation of the United Nations Ad Hoc Committee on the Peaceful Uses of Outer Space. Initially, the Soviets attempted to limit military activity in "cosmic space", while the U.S. proposed a broader base for international cooperation. The Soviet Union pulled out of the discussion and the possibilitiy of a binding agreement was lost. However, the Ad Hoc Committee's Twenty Power Draft Resolution embraced the principle of equality of all states in the exploration of outer space.

Six months after the Ad Hoc Committee's report, the General Assembly created a Committee on the Peaceful Uses of Outer Space (COPUOS) in December of 1959. A Legal Subcommittee and a Scientific Legal Subcommittee were also established. COPUOS and the U.N. remain the focal point of present negotiations in international space law.

The Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space was the first effort by the Legal Subcommittee. Called the Treaty on Legal Principles, it outlawed all weapons of mass destruction in orbit and rejected military bases on celestial bodies. The moon was declared a peaceful territory. The treaty also called for equal and full access to space installations, as well as environmental protections.

The 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space was simultaneously suggested by the U.S. and the USSR. It required that "objects found beyond the limits of the State of registry be returned to that state, which shall furnish identifying data upon request prior to return, and that states shall regard astronauts as envoys of mankind in outer space and render them all possible assistance. (Hahn, p. 430.) The tragic events surrounding the death of the Soviet cosmonauts and three Apollo astronauts highlighted the need for such an agreement. Though the agreement was signed, some debate has ensued. Many have claimed that nations might legitimately interpret the Rescue and Return Treaty as not inclusive of objects which it deems to have landed within its territory in violation of the United Nations Charter. (Hahn, p.430.)

The Outer Space Treaty was a response to a perceived need that the advent of men on the moon would create. The U.N. Legal Subcommittee had proposed treaties from both the U.S. and the USSR to work with. The Soviet draft regulated activities in outer space, as well as the moon and other celestial bodies. The U.S. draft contained provisions for reporting scientific information and free access to areas on celestial bodies. The final version combined the essential provisions from each country's draft.

Though the Outer Space Treaty prohibits "claims of sovereignty", when the provision is read with the "right of reciprocal inspection" such prohibitions are considerably diminished. The right of reciprocal inspection is nothing more than a claim of sovereignty based on territorial jurisdiction. The amendments to the treaty, therefore, do not represent a compromise, but a recognition of already hazy legal definitions. (Hahn, p 434.)

The 1972 Convention on International Liability for Damage Caused by Space Objects has had occasion for use in the Cosmos 954 incident. It established the rules of international liability caused by damage from malfunctioning satellites and a procedure for compensation that specifies currency. It calls for the establishment of a claims commission in such an event. The convention is also sensitive to the difference in the domestic laws of each nation. (U.N., Space Activities.)

The 1975 Convention on Registration of Objects Launched into Outer Space calls for the simple registration of launches with the Secretary General of the U.N. This would include the registration of markings on the vehicle. The Registration Convention marked the last multilateral U.N. agreement. (U.N., Space Activities.)

Major Treaties of the U.N.

- Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967).
- Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space (1968).
- Convention on International Liability for Damage Caused by Space Objects (1972).
- Convention on Registration of Objects Launched into Outer Space (1974).
- Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979--not signed by the United States).

Source: OTA Report, Civilian Space Policy and Applications (Washington, D.C.: Government Printing Office), 1982, p. 347.

Minor bilateral agreements have also evolved. The agreement between President Nixon and Premier Kosygin is an example. These agreements resulted in the joint docking of the Apollo-Soyuz spacecraft in July 1975. Like most bilateral arrangements, the Nixon-Kosygin agreement did not establish any firm technical or legal procedures. It did, however, provide the first commitment by both states to develop a mutually agreeable foundation for cooperation in space.

The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Treaty) has been rejected by the U.S. because it "is opposed to the private enterprise, profit motivation approach to space industrialization and, therefore, counter to American economic interests." The U.S. is not a party to all international agreements. Yet, it is primarily from the U.N. multilateral agreements that a body of international space law has begun to develop.

## International Law

The earliest commentaries on space law came from the Soviets in the 1920's and 1930's. In 1926, V.A. Zarzar wrote that full sovereign rights should extend throughout airspace and limited rights of self-defense should extend as far into space as national security interests might require. The preoccupation with disarmament and national security has been repeatedly evident in United Nations negotiations. (Doyle, pp.337-344.)

The use of the English language has been as important in space law as was French in the evolution of air law. Yet, the pivotal treaties was by the German author Vladimir Maude in 1932. "Das Weltraum-Recht" dealt with the potential problems of manned and unmanned space flight, as well as with opinions for extending international law. Maude dealt with modern day issues, such as vehicle licensing, information disbursement, oversight authority, delimination of outer space, accident liability, and national sovereignty. (Doyle, pp. 337-344.)

German Professor Alex Meyer, in 1952, was another national influence. His work began with sovereignty and regulation issues, building upon Maude's writing. These three gentlemen and their nations represent the origins of Space Law. (Doyle, pp. 337-344.)

The formal announcement of launch plans allowed the practical application of many of the earlier principles. Today's international law is dominated by four concepts that can be directly traced to the earliest writings. Each is currently found embodied in the Outer Space Treaty of 1967. The Principle of Free Use and Sovereign Equality of States explains that space "shall be free for exploration and use by all states without discrimination of any kind, on a basis of equality..." (Article I). The Principle of Prohibition of National Appropriation explains that celestial bodies are "not subject to national appropriation by claims of sovereignty." (Article II). The Principle of State Responsibility is pertinent "whether such activities are carried out by governmental agencies or by non-governmental entities..." (Article VI).

Legal Principles of Space Law:

- The Principle of Free Use
- The Principle of the Sovereign Equality of States
- The Principle of the Prohibition of National Appropriation
- The Principle of State Responsibility

Though not as legally firm, the Common Heritage of Mankind (CGM) principle maintains that "there are certain resources, such as minerals on the ocean floor and on the Moon, that are presently under the jurisdiction and control of no sovereign power." (OTA Report, p. 351.) Because these resources are exhaustible and unclaimed, they should be used equally by all nations. As seen in the '79 Moon Treaty, the Common Heritage of Mankind is the Common Property of Mankind. (OTA report, p. 351.)

The New World Order of Information is a loose legal principle that asserts that Western industrialized nations control both the amount and kind of information and communication available. A Soviet proposal, it seeks to; (1) encourage the development of a third world information infrastructure; (2) control the West's access to developing countries; and (3) limit the Western media's ability to disseminate information in developing countries. Due to uncertainty over the long term effects of the principle, as well as the Common Heritage of Mankind, the U.S. has not presently offered its support. (OTA report, p. 352.)

## International Competition

The fight for prestige remains at the center of motivation for negotiating nations. Competition among launching states has heightened what was once a struggle between the superpowers. The Third-World has taken an active interest in insuring their future. The issue of competition, though it will not appear on the agenda, will remain an underlying issue.

## Technology Transfer

The transfer of technology can come in two forms. Space-related technology involves the launch vehicles and facilities for guidance, command, and control of launchers and satellites. Applications-related technology consists of sensor systems, communications equipment, data collection, and processing technologies. Space-related technologies and the actual data collected (e.g., remote sensing images) have been more easily transferred.

In the U.S., NASA has made a conscious effort to enhance the spillover effects of technology. Their publications quickly disseminate the latest technology to private industry. These "spin-offs" have included teflon coating, microwave ovens, and the microchip. The dispersal of data is part of an "open policy", which has enhanced our competitors, as well as those at home.

The concern for economic growth in the third world has dominated much of the thinking in international negotiations. Lesser developed countries (LDCs) have long called for technical assistance and foreign aid to enable them to exploit technology. The New World Information Order and the New Economic International Order have allowed for programs like communications and remote sensing to be part of such technology transfers. (See International Law.) For example, many underdeveloped countries have ground stations for the reception of U.S. Landsat Data.

The U.S. has made many promises of technical assistance, but has been slow in delivering on those commitments. This is due to a dispute over what mechanism should be used for funding (whether it should be through voluntary contributions to U.N. activities or through the regular assessed budgets of the U.N. and its agencies.) (Smith, p. 11.) Lesser developed countries have pushed for both avenues, while the U.S. has supported the former. Recently, U.S. monetary support to the transfer of technology has been diminishing.

Projects such as the United States Academy for International Development's (AID) Satellite Instructional Television Experiment (SITE), which brings educational television to more than 5,000 Indian communities, is an alternate approach to direct technological aid.

The U.N. mechanism for technical assistance to member states is UNESCO. They have worked with several third world nations in assessing communications needs and are conducting long-range studies into satellite applications for educational and cultural programming to developing areas. They also work to promote the free flow of information policy. (OTA Report, p. 348.)

## Telecommunications

Telecommunications was the first issue to evolve from unmanned spacecraft in orbit. The International Telecommunications Union (ITU), an international, intergovernmental organization, is the United Nation's related agency for telecommunications. The purpose of ITU is to coordinate and regulate international activities in the field of communications. To allocate radio frequencies for space, the ITU's World Administrative Radio Conference (WARC) has been holding meetings since 1959. WARC, together with Regional Administrative Radio Conferences (RARC), are the means by which the technical coordination and regulation of international communications is actually set. Technical advice, as well as the review of registration of frequency and orbit assignments is handled by the International Frequency Registration Board (IFRB) of ITU. The decisions of these groups have the force of international treaties. (OTA Report, p. 348.)

Telecommunications no longer has the level of controversy that once surrounded it. It is accepted as a necessary part of our daily lives. Companies such as Comsat and Intelsat have evolved to provide operational services, while NASA handles research and development projects. The issues that effect the telecommunications area today are not directly related, but, as space technology increases in development, the importance of these issues will surely rise as well.

## Direct Broadcast Satellites (DBS)

Direct Broadcast Satellites are communications satellites capable of transmitting signals strong enough to be received directly by individuals who have small antennas. The elimination of elaborate terrestrial distribution systems would make possible the transmission of programs to widely disbursed populations, remote areas, and to countries without a sophisticated communications infrastructure. DBS technology offers the potential for large-scale educational, health, and public service programming.

Despite all the benefits such a system could offer, there is concern over the possible socio-political implications. The benefits could optimally be felt in the third world. "The political values they (lesser developed countries) attach to such concepts as cultural integrity and national identity take precedence over the more pragmatic values of efficiency and cost savings that are associated with a less restrictive approach to the application of new technology, (as in direct broadcasting)." (Effects on International Discussion.) Fearing the possibility of cultural and economic imperialism, developing countries feel DBS would create social unrest.

Third-World nations have joined the Soviet Union and France in arguing that sovereignty rights prohibit broadcasting across national boundaries, unless previously arranged. The U.S. has stood against this view because; (1) a policy of free flow of information would be disrupted by any prior consent principle, (2) there is insuffcent experience with DBS to place political constraints, (3) any enactment of a set of principles might restrict further development of technology, and (4) present ITU regulations constitute a sufficient safeguard against unauthorized DBS transmissions. (OTA Report, p. 354.)

The Soviet Union strongly backs the belief that DBS could be used to spread propaganda and misinformation. Joint Canadian and Swedish proposals have suggested that a compromise is possible. Though real support does not exist as yet, such a compromise would involve previous arrangements between foreign governments, while leaving the content of the transmissions to the discretion of the broadcaster.

COPUOS has been working on a set of principles for direct broadcast satellites since 1968. The split between those who push for the free flow of information and those who advocate a regime of prior consent has pre-empted any decision. These principles of debate include purposes and objectives, applicability of international law, rights and benefits, international cooperation, state responsibility, consent and participation, spillover, program content, unlawful/inadmissable broadcasts, duty and right to consult, peaceful settlement of disputes, copyright, neighboring rights and protection of television signals, notification to the U.N. system, and disruption. (U.N. Space Activities.) At present, an agreement has yet to be reached.

The Federal Communications Commission (FCC) of the U.S. on June 23, 1982, approved a frequency for DBS. Nine companies have filed with Comsat for the first contract. The U.S. has made the first move toward an operational system.

Countries Actively Planning DBS Systems (12 GHz)

| Country | Name | Data For 1st Launch | Type of Service | Present Status |
|---|---|---|---|---|
| Canada | Hermes | 1976 | Experimental | Defunct |
| Japan | BSE | 1978 | Experimental | Partially Active |
| Japan | BSE-II | 1984 | Operational | Specification |
| Germany | T-V-Sat | 1984 | Pre-Operational | Development |
| France | T-V-Sat | 1984 | Pre-Operational | Development |
| Luxemburg | Luxsat | 1983(?) or 1985 | Operational | Management Decision Re: Strategy is Imminent |
| Scandinavia | Nordsat | -- | | Discussion |
| Switzerland | Tel-Sat | -- | | Discussion |
| Italy | L-Sat-Package | 1984 | Experimental | Planning |
| U.S.A. | Comsat | 1983(?) | Operational | Planning |
| Australia | Domsat | 1984 | Operational | Specification |

(?) considering status, difficult to believe

Source: AID Rural Satellite Program Library; Academy For Academic Development; Clippings File, "Direct Broadcasting Satellites."

## Remote Sensing

Remote sensing technology is the use of cameras and sensors to analyze the natural phenomena of the earth. Satellites gather the information by detecting reflected or emitted electromagnetic radiation. The U.S. Landsat Remote Sensing System has applications in agriculture, hydrology, geology, land use planning, environmental monitoring, and marine and ocean resources. In the past five years the Soviets have also begun sensing in the Meteor 2 series of flights. Such data can have political, economic, and military implications.

There are several problems of legal significance. Sovereignty has been closely linked with territorial control. The U.S. feels that the problems of territorialism will take a back seat to the optimum use of technology by all. The Soviet Union has sought to protect itself from territorial intrusion by voicing a protectionist philosophy. Developing nations have sought an absolute right to deny sensing rights, and if sensed, total control of the dissemination of the information. (Hahn, p. 430.)

Sovereignty claims have brought out moves for prior consent, restricted data dissemination, and limited resolution. The U.S. has generally opposed the placing of restrictions on remote sensing activities or the data derived. An area which has also caused some concern is the liability of the state doing the sensing. Beyond the problems of satellite collision and terrestrial damage, legal harm may be inflicted through either loss of economic advantage or the convert use of information.

Legally "a sovereign nation may protect itself from information gathering activities within its borders, either on the ground or from the air.
The legal basis for each of these manifestations of sovereignty is not necessarily applicable to outer space activities." (OTA Report, p.355.) The strongest action has come from the U.N., which did not formally recognize remote sensing technology until late 1969. Though an initial effort by Argentina was rejected, "by the

end of the early seventies the stage was set for the effort to develop a convention regarding remote sensing and the developing countries were emerging as the primary players." (Hahn, p. 443.) The years ahead saw a division between those states desiring the benefits of the technology (developing countries), those states in possession of the technology (the United States), and those states possessing the technology, desirous of its broad application, but insisting upon a strict adherence to traditional notions of sovereignty (Soviet Bloc countries.) (Hahn, p. 443.)

The Committee on the Peaceful Uses of Outer Space and the Scientific and Technical Subcommittee established a Working Group on remote sensing in 1971 to help resolve the issue. The Science and Technology Subcommittee was able to settle some technical issues in its 1974 Working Group Report. The Legal Subcommittee of COPUOS failed to deal with the problem until quite late. In 1976, however, it was able to reach agreement in five areas. These were:

1. That the objectives of remote sensing benefit all mankind,
2. That international law, specifically the U.N. Charter and the Outer Space Treaty, were applicable to remote sensing,
3. That the success of any remote sensing activitiy would depend upon international cooperation and participation,
4. That the primary benefit of remote sensing activity was the protection of the environment, and
5. That any treaty must contain a provision whereby the sensing states could be required to render technical assistance to the developing nations. (Hahn, p. 454.)

It should be noted that there have also been suggestions that the U.N. itself take charge of remote sensing data.

## Delimination of Outer Space

The question of where the physical boundary lies that divides air space and outer space has not been decided. Though such considerations have plagued legal theorists since the beginning of the space age, no rule of law has been found which defines the extension of the sovereignty of a state in altitude. Thus, high limits are placed in the 1967 Space Treaty, which establishes a regime of exploration and use.

The delimination of outer space, closely linked with the legality of the geostationary orbit, has appeared on the agenda of the United Nations Committee on Outer Space since the early sixties. Technical, biological, functional, and many other bases have been explored for definition. During the sixties a German Jurist developed the Von Karman Zone. "This zone is established by reference to a diversity of elements such as the composition of air, the biological and physiological possibilities of life, and other factors which lead to the determination of an area beyond which airspace no longer exists as such". (Williams, p. 662.) The theory was supported by Andrew G. Haley and several Latin American writers.

The Buenos Aires Resolution of the International Law Association received wide support after its 1968 adoption. The Space and Air Law Committees jointly developed the following:

> "...the term 'outer space' as used in the Outer Space Treaty of 1967, includes all space at and above the lowest perigee achieved by the 27 January 1967, When the Treaty was opened for signature, by any satellite put into orbit, without prejudice to the question whether it may or may not later be determined to include any part of space below that perigee." (Williams, p. 663.)

The Resolution has served as the center of many agreements in international law. However, because of recent advances in much lower satellite orbits, aeronautical law could become applicable.

In August 1978, at the 58th Conference of the International Law Association in Manilla, it was agreed that claims of sovereignty above 100-110 km could hamper the activities of states and international organizations in space. (ILA Report, p. 13.) Though the finding was very similar to the Von Karman suggestion, the over-riding concern has been that of "national security". The problem is no longer technical, but is now political.

It is presently the U.S. position that no decision should be made until a more definitive understanding of the scientific and technical characteristics of low-orbit satellites become available. There remains no internationally accepted definition of the borders of outer space.

## Geostationary Orbit (GSO)

Ideal for communications satellites, geostationary orbit (GSO) is located at 35,800 km above the earth and extends for 260,000 km. Geostationary satellites are those whose circular orbit lies in the plane of the earth's equator and which turns around the polar axis of the earth in the same direction in a period similar to the rotating of the earth. (Geosynchronous satellites are earth satellites whose period of revolution is equal to the period of rotation of the earth around its axis.) Present technical limitations would permit only 180 satellites to be placed in such an orbit. (Williams, p. 664.)

The U.N. Working Group on Direct Broadcasting Satellites and the 1971 Geneva Conference on Space Communications have both declared geostationary orbit to be a limited outer space resource. International Telecommunications Union (ITU) standards of conduct point out that radio frequencies and geo-orbits are limited. Yet, neither customary nor treaty law can restrict the 1967 Space Treaty provision for the "freedom of exploitation and use" of space, so long as the interests of other states are not jeopardized. The Radio Regulations of the ITU establish the privilege of geostationary satellites, though if unacceptable interference is caused, a reduction in radio emissions or total shut down might be called for. Concerned administrations set such guidelines. (Williams, p. 665.)

Orbit allocation is based on the first-come-first-served principle, though subject to ITU approval. During the seventies, lesser developed countries began to call for a guarantee of future access to certain limited space resources, citing the 1967 Treaty which lays down the principle of equality. Developed countries oppose such a plan because universal access and optimal usage would not be achieved. Also it is thought that technical advances may solve the problem. In the 1976 Bogota Declaration eight equatorial countries claimed that they own part of the GSO that transverses their country. The 1977 U.S. Declaration to the Outer Space Committee states that geostationary orbit is nothing more than a flight path system. Ignoring claims of national sovereignty, the U.S. views GSO as a part of its "grey skies" policy. The U.S. has backed the ITU and other U.N. related activities.

## Nuclear Power Sources in Space

In early 1978 the Soviet Satellite Cosmos 954 fell from orbit into northern Canada. Used for ocean surveillance activities, it was powered by a small nuclear reactor. Disfunction of the vehicle caused nuclear debris to be spread over a wide area. ("Cosmos Incident", p. 56-59.)

Since both parties were signatories to the Liability Convention, the matter was brought before the U.N. The use of nuclear energy to power satellites was referred to COPUOS. Though no international consensus has been reached, it is looking into safety, prior notification, emergency assistance, and liability for damages.

The Soviet Union is presently the only country which uses nuclear reactors in space; the U.S. uses non-reactor nuclear power sources like the radioisotope thermal generators (RTGs) which use heat from the decay of a small amount of plutonium-238 to generate electricity. (Smith, p. 12.)

## Military Use of Outer Space

Throughout its history COPUOS has dealt with issues of militarization. Though often not on the agenda, issues such as remote sensing come into play as countries voice concern about intelligence operations. There has always been "utility of spacecraft for military reconnaissance, weather observation, communications, navigation, and geodesy..." (Smith, p. 7.) What most concerns national and international circles, however, is the use of weapons in space.

The 1963 Treaty on Legal Principles bars nuclear weapons and other mass destruction weapons in orbit. In addition, it does not allow military bases on any celestial body. Developments, such as the Soviet Union's operational weapons system for use against satellites (called an antisatellite, ASAT), and reports of a Soviet "battle station" in orbit, have caused international alarm. In the fall of 1981, the Soviets introduced a draft treaty to the U.N. General Assembly to ban the stationing of weapons in space, with special reference to the U.S. Space Shuttle. (Rich, p. 662.)

The U.S. feels that the Disarmament Conference should handle the issue of space militarization. Though it may not appear on an official agenda, militarization is bound to remain an underlying issue.

## Conclusion

In reviewing the history of international involvement in space, it is clear we are still in an exploratory stage. In our two decades of experience we have resolved little. The issues remain the same. What has changed is that the two superpowers no longer stand alone. Both developed and undeveloped nations have called for a voice on issues of sovereignty and equal access.

The U.S. has had a history of ignoring the United Nations. Yet, with the proliferation of interested nations, this will have to change as discussed previously. There has been an increasing reliance upon the U.N. in issues such as space policy.

The U.S. has always entered U.N. negotiations and conventions in strict recognition of only the technical issues. Technical issues cannot be divorced of political policy, as with geostationary orbit and remote sensing. A new political emphasis could allow the U.S. to enter international forums more prepared, with a view to something more than minimizing losses.

## Selected Bibliography

Civilian Space Policy and Applications, OTA Report, (Washington, D.C.: Government Printing Office), 1982.

"The Cosmos 954 Incident and International Space Law," American Bar Association Journal, Vol. 65, January 1979.

"Direct Broadcasting Satellites," Clippings File, AID Rural Satellite Program Library; Academy for Academic Development.

Doyle, S.E., "Original Contributions to Concepts of Space Law," Astronautics History, August 1981.

Effects on International Discussion of DBS, unpublished doctoral dissertation, summarized in Cover and Love (Hall Street), Report to OTA; The Committee on the Peaceful Uses of Outer Space and, the Outer Space Affairs Division of the United Nations, unpublished, June 6, 1982.

Hahn, Joseph John, "Developments Toward a Regime for the Control of Remote Sensing From Outer Space," Journal of International Law and Economics, Vol. 12, No. 3, 1978.

Report to the Manila Conference of the ILA; Space Law Committee, unpublished.

Rich, Vera, "Soviet Union Urges Space Demilitarization," Nature, Vol. 292, August 20, 1981.

Smith, Marcia, "Issues Concerning Global Space Policy," Congressional Research Service Issue Brief, (Washington, D.C.: CRS Library of Congress), 1982.

Space Activities and Resources/United Nations, Dept. of Political and Security Council Affairs, New York, 1977.

Space Activities of the United States, Soviet Union, and Other Launching Countries/Organizations: 1957-1981, Congressional Research Service, Library of Congress for the Subcommittee on Space Science and Applications, (Washington, D.C.: Government Printing Office) June 1982.

Williams, Maureen, "The Geostationary Orbit: A Limited Natural Resource From Outer Space," International Relations, Nov., 1979.

# PROPOSED CREATION OF A UNITED NATIONS CENTRE FOR OUTER SPACE

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# PROPOSED CREATION OF A UNITED NATIONS CENTRE FOR OUTER SPACE

## A. INTRODUCTION

The United Nations will sponsor the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) from August 9-21, 1982 in Vienna, Austria. The U.N. Committee on the Peaceful Uses of Outer Space (COPUOS) serves as the preparatory committee for this conference, and Yash Pal of India is the conference's Secretary-General. As part of the preparatory activities, Mr. Pal led the effort to draft a final report of the conference, which will be discussed, amended (if necessary) and adopted in August. One part of the draft report recommends establishment of a U.N. Centre for Outer Space, which according to Mr. Pal is a compromise between those who did not want any new organization created, and those who wanted to establish a separate U.N. agency for space.

This report abstracts the proposed structure and functions of the U.N. center and reaction to the idea, based on the draft UNISPACE 82 conference report and on U.N. press releases summarizing the discussion in COPUOS after the draft was introduced (the press releases are not official transcripts, however). A section is also included describing other U.N. agencies and departments which already have a role in space matters, based on information provided in the UNISPACE 82 draft report.

## B. ORGANIZATION AND FUNCTIONS OF THE PROPOSED CENTER

The proposed U.N. Centre for Outer Space would be created not to consolidate all the activities being carried out by the various U.N. agenices into one international space agency, but rather to establish a focal point for increased coordination and organization of agency activities, thereby strengthening the role of the United Nations in space matters.

The functions of the center would include:

(a) Existing tasks of the U.N. Outer Space Affairs Division, with a strengthening of technical expertise, and would have additional responsibility for the centralized servicing of COPUOS;

(b) Implementing a reoriented space applications program -- helping developed and developing countries to choose, execute, and make beneficial, appropriate applications;

(c) Organizing and operating a space information service that would initially provide access to existing space data to any Member State through the United Nations and later keep an exclusive space information data bank for U.N. purposes;

(d) Servicing ad hoc task forces appointed by COPUOS to conduct specific studies;

(e) Participating in, conducting, or organizing various studies; and

(f) Helping to implement -- through appropriate organs of the United Nations -- the finally approved decisions of UNISPACE 82, and carrying out all preparatory and background studies for this purpose.

According to the draft UNISPACE 82 report, the center would require organizational autonomy, and would be headed by an experienced director at a "sufficiently high level." The center's personnel would be multidisciplinary, but it might not be necessary or possible to have a permanent staff in all required disciplines. Thus the center should be able to recruit experts for brief periods of time.

The center would work closely with the various technical agencies within the U.N. system (particularly the International Telecommunication

Union, the World Meteorological Organization, the Food and Agriculture Organization, and the Natural Resources and Energy Division of the Department of Technical Cooperation for Development), and with funding agencies such as the World Bank and the United Nations Development Program. The center could provide a closer linkage between U.N. agencies concerned with the scientific and technical aspects of space, and agencies that are involved with U.N. development programs and international economic cooperation. The center would also perform studies and research on the militarization of space, to the extent that COPUOS is involved, in cooperation with the Centre for Disarmament and other appropriate agencies.

COPUOS would continue to act as the focal point for all space-related activities in the U.N. system, and would be the only inter-governmental body in the U.N. exclusively concerned with peaceful uses of outer space.

The first task of the Centre for Outer Space would be implementing the finally approved recommendations of UNISPACE 82, eventually becoming a source for data and research and the servicing of other U.N. agencies. The center would require approximately $5 million per year, which would come from voluntary contributions (not from the regular assessed budget of the U.N.).

## C. INITIAL REACTION TO THE PROPOSAL

The draft UNISPACE 82 report was debated at the January meeting of COPUOS. Since the draft had only been received by most of the COPUOS members shortly before the debate began, all comments were preliminary in nature. Thus, not all countries commenting on the draft report specifically responded to the idea of the Centre for Outer Space. The record from which the following material is abstrated is unofficial.

The representative from India commented that when establishing new systems, one must take into account the defects of the existing system. He also commented that the importance of self-reliance should be considered, and that many of the things that come through the international system as gifts are not going to help anybody.

The Romanian delegate stated that the problem was how to make the best use of existing bodies dealing with space issues, and that the absence of additional bodies had not so far inhibited the development of space-related activities. He added that when establishing new bodies, certain traditional norms had to be considered, for example, assurance that States representing the broadest possible range of interests be included.

The Egyptian representative supported the central role of the United Nations in any international cooperation effort, and stated that Egypt would like to carry the proposal for the Centre for Outer Space a step further.

The Japanese delegate stated that Japan was not yet convinced that the creation of a new body was necessary. The representative from the Federal Republic of Germany added that proposals for new structures should be scrutinized, and that various U.N. specialized agencies could be further involved in different space programs.

Countries which commented on the draft report, but did not make specific references to the proposed center, included: Australia, Austria, Brazil, Chile, China, France, German Democratic Republic, Italy, Netherlands, Pakistan, Philippines, Soviet Union, Sweden, Syria, United Kingdom, and the United States.

A representative from the U.N. Department of Technical Cooperation for Development also commented on the draft report, and stated that some of the proposed activities seemed duplicative with those of her department, particularly those in the area of remote sensing assistance.

## D. EXISTING U.N. SPECIALIZED AND ASSOCIATED AGENCIES INVOLVED IN SPACE MATTERS

The draft UNISPACE 82 report identified the existing U.N. organizations already involved with space matters. The following summary of those agencies and their space-related activities is based on information in the draft report.

### 1. Committee on the Peaceful Uses of Outer Space (COPUOS)

Established in 1961, COPUOS is the nucleus of all space-related activities within the United Nations. The committee, comprised of 53 nations, has the mandate to review the area of international cooperation in the peaceful uses of outer space and to study practical and feasible means for effecting programs which promote such cooperation. It also studies the legal problems that might arise from the exploration and uses of outer space and organizes the exchange and dissemination of information relating to space activities. The committee has two permanent subcommittees: legal, and scientific and technical.

### 2. Outer Space Affairs Division

COPUOS is serviced by the Outer Space Affairs Division of the United Nations Secretariat. The Division has the responsibility to implement decisions of the committee related to the promotion of international cooperation and peaceful uses of outer space. It oversees the space applications program, which was initiated in 1969 as a result of the first U.N. Conference on the Exploration and Peaceful Uses of Outer Space.

### 3. Natural Resources and Energy Division

Within the Department of Technical Cooperation for Development, the Natural Resources and Energy Division is responsible for a broad program of activities in the fields of cartography, energy, geology and mining, and water resources. The program focusses on meeting the needs of developing countries and is divided into two types of activities: operational or field projects for technical assistance, and non-operational projects including studies, seminars, and conferences. The use of remote sensing as a tool for resources exploration is of primary interest to the Natural Resources and Energy Division.

### 4. Office of the United Nations Disaster Relief Coordinator (UNDRO)

UNDRO was established in 1972 to mobilize, direct, and coordinate relief activities of the U.N. system in response to requests from countries to promote the study, prevention, control, and prediction of natural disasters, and also to advise on pre-disaster planning.

UNDRO is currently studying the use of satellites for obtaining imagery for post-disaster relief coordination purposes, and sponsors training programs in the use of remote sensing for disaster forecasting.

5. United Nations Environment Program (UNEP)

UNEP, created in 1972, has duties which include coordinating environmental programs within the U.N. system, keeping their implementation under review, and assessing their effectiveness. UNEP has a special interest in the use of satellite remote sensing for the systematic collection of environmental data. Remote sensing could play an increasingly important role in UNEP activities related to agriculture and land-use practices, climate monitoring, global ozone monitoring, etc.

6. United Nations Development Program (UNDP)

Among its world-wide activities, UNDP has funded many projects in the space field. The majority of these projects are in the three fields of natural resources surveys, technology transfer, and planning. UNDP is especially interested in programs for communications, weather and pest forecasting, radio and television broadcasting for development, and resource surveys. Current projects include development of an experimental satellite communication Earth station and the organization of relevant on-site training courses.

7. World Meteorological Organization (WMO)

The advent of artificial satellites has had a considerable impact on the activities of the WMO and has resulted in significant benefits to national meteorological services throughout the world. The use of satellites not only increases the amount of data available, but also provides a means for the collection and distribution of information in support of various

WMO programs including the World Weather Watch and the Global Atmospheric Research Program. Practically all of the constitutent bodies of the WMO are engaged directly or indirectly in outer space activites.

## 8. International Telecommunication Union (ITU)

ITU and its related organs have played a major role in the systematic planning and regulation of space activities through coordination, allocation, and registration of radio frequency bands for various uses. For example, since 1973 the International Frequency Registration Board (IFRB) has had the responsibility of recording the positions assigned by countries to geostationary satellites. ITU committees carry out various studies through working groups composed of experts from various countries in an effort to promote close cooperation and understanding between nations. As the demand on resources like geostationary orbit increases, there will be greater need for cooperation.

## 9. Food and Agriculture Organization of the United Nations (FAO)

Since 1969, satellite imagery has been used by FAO as an aid to its many activities. In 1976, FAO set up a remote sensing unit in recognition of the great utility of space techniques to its work. In 1980, this unit became the Remote Sensing Centre which undertakes the following functions: advisory services and technical assistance to Member States, training courses for developing countries, support to the FAO field programs, coordination of remote sensing activities at FAO headquarters and in the field, and serving as the liaison point between FAO and other major organizations concerned with space applications.

## 10. United Nations Educational, Scientific and Cultural Organization (UNESCO)

UNESCO's interest in space lies primarily in space communications. Experts have been sent by UNESCO to various countries to study the feasibility of satellite communications and it has acted as executing agency for UNDP-funded projects aimed at satellite broadcasting experiments. UNESCO has been a forum for the discussion of matters relating to satellite broadcasting, and has also, in connection with studies of the natural environment, taken an interest in remote sensing of the Earth by satellites and other spacecraft.

## 11. Inter-Governmental Maritime Consultative Organization (IMCO)

Since 1966, IMCO has taken a considerable interest in the development of space technology for maritime purposes, culminating in the creation of INMARSAT. IMCO now has developed requirements for a future global maritime distress and safety system which is expected to be implemented by 1990. This system, to be developed closely with ITU and INMARSAT, will make use of low-power distress transmitters operating through geostationary and polar orbiting satellites.

## 12. International Civil Aviation Organization (ICAO)

One of ICAO's objectives is the economic application of satellite services to international civil aviation. The aeronautical fixed service already utilizes satellite communication links where available and feasible. Satellites could benefit the aeronautical mobile service by providing instant, static-free communication between pilots and controllers over all parts of the Earth's surface. The aeronautical radio navigation service has a need for satellites to provide radio-determination of aircraft position during flights.

ICAO is also concerned with the use of satellites for search and rescue services, the definition of outer space, transport to and from, and through, outer space, problems related to safety, including hazards caused to civil aircraft in flight by space debris returning to Earth, etc.

## 13. World Bank

The World Bank has been involved in the funding of telecommunications earth stations for domestic and international traffic. It also has an active interest in remote sensing and is involved in studying the feasibility of using satellites for education.

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# NATIONAL PAPER OF THE
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## I. INTRODUCTION

Since the first UN Conference on the Peaceful Uses of Outer Space in 1968, it has been demonstrated that the peaceful exploration and utilization of the unique attributes of outer space can make a major contribution to social and economic development here on Earth. Communications, meteorological, land and ocean sensing satellites have provided greatly improved telecommunications and weather services and made available vast amounts of data for use in other applications. As a result, our understanding of the universe, our knowledge of the Earth environment and our ability to manage its resources have already increased dramatically. Many "spin-offs" of technology from space programs have become parts of daily life both in the developed and the developing world. International cooperation in this area, through bilateral and multilateral cooperation among nations and through various UN organizations, has contributed substantially to the spreading of the benefits of space technology to both developing and developed nations. The United States is proud to have played a leading role in this process.

Much work needs to be done, however, to make the benefits of the peaceful uses of outer space still more accessible and affordable to more countries. With this as one of its major goals, the U.S. seeks to maintain a vital research and development program which will yield advances in all areas of civil space exploration.

The United States intends to maintain its international leadership role in the use of outer space. In carrying out its national and international space activities, the U.S. adheres to the principles of peaceful uses of outer space embodied in the legislation, the National Aeronautics and Space Act of 1958, which established the U.S. National Aeronautics and Space Administration (NASA), as well as those of the subsequent 1967 United Nations Treaty on the Exploration and Peaceful Uses of Outer Space.

In addition to NASA, the Agency for International Development (US/AID), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS) and U.S. Department of Agriculture (USDA), along with U.S. private industry and the academic community have played key roles in the peaceful use of outer space and have helped to establish U.S. leadership in this area.

Since the inception of the U.S. space program, the application of space activities for the benefit of both the national and international communities has been one of its major objectives. The law establishing NASA specifically requires it to conduct its activities "so as to contribute materially to...cooperation by the United States with other nations and groups of nations." Information about U.S. space programs, both present and future, and their results is made widely available to the world community. At the same time, the U.S. encourages international cooperation and has developed an extensive program of international activities open to participation by non-U.S. space agencies, academic organizations and individuals.

In the past two decades the U.S. has concluded over 1000 agreements in space activities with scientists and organizations in over 100 countries.* The U.S. believes that specific, national-level cooperative agreements continue to offer the most effective structure for international cooperation in the development of space technology for the benefit of all.

The U.S. encourages international participation in its programs because it believes that the cause of scientific and technological progress is best served by following this course. Non-U.S. scientific and technical contributions to U.S. space programs have significantly enhanced their scientific return. By sharing the costs, intellectual efforts and returns (tangible and intangible), the participants in such cooperation achieve far more than they could separately. In structuring these cooperative agreements, the U.S. has followed several principles which have been found, through experience, to yield the most satisfactory results for both parties.

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*For more detailed information on U.S. cooperative programs in space, see A Review of NASA International Programs As of January 1, 1982, prepared by the International Affairs Division, NASA Headquarters, Washington, D.C.; also see the Review of United States' National and Cooperative International Space Activities for the Calendar Year 1981, prepared by the United States for publication by the U.N. Committee on the Peaceful Uses of Outer Space.

First, the U.S. has sought to conclude agreements for cooperation on a project-specific basis. Umbrella agreements calling in general terms for cooperation in space have generally not been concluded. Instead, the U.S. has sought cooperation aimed at specific agreed objectives, where the success of the cooperative activity may be readily measured by demonstrable accomplishments.

Second, the U.S. has not sought cooperation for cooperation's sake, but has directly related its international cooperative activities to its programmatic objectives. These activities have become integral ot its programs; they are not merely cosmetic adjuncts.

Third, the U.S. and its cooperative partners have each brought to their partnership the necessary budgetary and intellectual resources to carry out their agreed roles in the particular activity. This has yielded predictable advantages.

A number of nations have developed the capability to carry out ambitious space ventures on their own. This in turn offers the U.S. increasing opportunities to participate in space projects of other countries. For example, the U.S. will not undertake a mission to Halley's Comet, but ESA has decided to pursue a European mission, "Giotto." U.S. scientists are to participate in the European mission. NASA will provide ESA tracking support through its Deep Space Network on a reimbursable basis, and will also finance participation by some U.S. co-investigators on the European experimenter teams. The U.S. is also exploring prospects for similar participation in programs of other countries such as the Federal Republic of Germany and Japan.

Finally, the United States will continue to make available on a reimbursable basis NASA space launch services utilizing both the Space Transportation System (Space Shuttle) and expendable vehicles. This service will be available on a nondiscriminatory basis to countries, international organizations and business firms wishing to engage in the peaceful uses of outer space.

The valuable role of the UN Secretariat, UN specialized agencies and other international organizations in assisting countries to benefit from the peaceful uses of outer space is important and is well documented in the excellent background papers prepared for UNISPACE '82. These bodies have publicized and disseminated information about space technology and have thereby assisted developing countries, in particular, in appraising the potential costs and benefits of space activities for their economic development. These organizations have also provided extensive training opportunities, organized seminars, conducted demonstration projects with space technology and sponsored programs to help countries establish the capability to utilize space technology. The U.S. has encouraged and helped support many of these activities. Such activities should receive the continued support of the Member States of the UN and efforts should be undertaken to make the role of the UN in these aspects of cooperative space activity even more effective.

Rather than attempting to provide a comprehensive description of the U.S. space program, this paper focuses on those aspects of particular interest to the developing countries. These include remote sensing, satellite communications, non-space "spinoffs" resulting from U.S. space programs and development of the U.S. Space Transportation System. Because of the substantial international involvement and interest in the NASA Space Science programs, these will also be briefly reviewed.

## II. REMOTE SENSING

Satellite remote sensing is a key example of practical benefit derived from the U.S. space program. The U.S. has consistently focused its efforts in this field on the development of practical applications of these advances, so that greater benefits can be realized by the national and international communities. Three major aspects of the earth are covered: the atmosphere, ocean surfaces and land surfaces. Data about these three realms, acquired via earth-orbiting satellites, yield valuable information helpful in characterizing and managing the Earth's natural resources and environment.

The U.S. supports public, non-discriminatory dissemination of remote sensing data from Landsat and U.S. meteorological satellites. In addition, the U.S. has encouraged open availability of such data through its international cooperative programs. These policies have already led to innumerable beneficial applications of remote sensing worldwide. Open availability of these basic data has fostered effective application of remote sensing to such important problems as desertification, food and fiber production, and flooding and water pollution, all of which transcend national boundaries.

## A. ATMOSPHERE AND OCEAN SURFACES

One of the most successful global demonstrations of the peaceful uses of outer space is the U.S. environmental satellite program. In operation since 1960, this space/ground system depends upon remotely-sensed data acquired from both the polar orbiting and GOES (Geostationary Operational Environmental Satellite) geostationary spacecraft operated by the U.S. National Oceanic and Atmospheric Administration (NOAA). The U.S. plans to launch both types of satellites throughout the 1980s. The system currently in place emphasizes the acquisition of atmospheric, oceanic and hydrologic data.

The system is fully accessible to any potential user and is designed to encourage international participation. Through conventional radio and satellite telecommunications facilities nearly every country in the world can receive valuable meteorological information. This includes severe storm warnings, upper air observations of areas where data are otherwise difficult to collect, and global sea surface temperature observations. Such information is compiled at the data reception and processing facilities of NOAA's National Earth Satellite Service (NESS).

## 1. Applications

Meteorological data from U.S. satellites is received directly by local stations in over 120 countries, both extending their observational capabilities and contributing substantially to their local weather forecasting capabilities. Cloud images obtained from polar orbiting satellites permit an assessment of frontal strength, storm intensity, surface and upper air wind direction, location of upper wind patterns and mid-tropospheric storm centers, surface low positions, and relative atmospheric stability. Continuous infrared imagery from geostationary satellites makes it easier to identify and track rapidly moving storm centers near the jet stream, which are often difficult to identify and track where conventional weather data are sparse.

Aviation services worldwide have benefited from imagery received directly from environmental satellites, revealing areas of significant inflight weather. Satellites often are the only source of weather information for safe aircraft operations in regions where data gathering networks are underdeveloped and communications poor.

A number of rainfall-estimating procedures have been developed which empirically relate satellite-viewed clouds to quantitative rainfall amounts. Rough estimates for periods of 12 to 24 hours have proven important in areas where few rain-gauge measurements are available and information is needed for crop prediction and water resource planning.

Most of the data from the U.S. Seasat instruments have been archived and analyses demonstrate the technological ability to make significant scientific observations of the oceans surface from space. Data from the Seasat altimeter have improved knowledge of the marine geoid and of significant wave heights and winds over the course of the mission. Satellite observations of major ocean currents compare favorably with surface observations taken at the same time. The utility of scatterometer measurements of sea surface winds has been demonstrated, particularly for improving weather forecasts.

Ocean color observations from the Coastal Zone Color Scanner on Nimbus-7 have been used to quantify ocean chlorophyll concentrations, to estimate regional primary productivity, and thereby to improve the efficiency of the fishing industry and fisheries management. Direct reception of these data from the spacecraft is available to other countries without restriction.

Environmental observation data from U.S. meteorological satellites are also useful in diverse areas such as the following: weather forecasts affecting crop yield and harvesting; monitoring of sea ice extent and movement; monitoring the areal extent of snow cover; regulation of river and coastal fishing activities; routing of ships; coordination of logging operations; control of desert locusts; and monitoring of dust storm formation and movement.

## 2. Contributions to International Organizations

U.S. meteorological satellites have made a significant contribution to international environmental programs, including cooperative programs carried out by the World Meteorological Organization (WMO). For example, data provided from U.S. satellites are a major contribution to the Global Observing System of the WMO World Weather Watch.

The U.S. is an active participant in the Global Atmospheric Research Program (GARP). One of the largest and most complex scientific undertakings ever attempted, was the First GARP Global Experiment (FGGE) conducted in 1979. The U.S. contributed satellite data consisting of cloud-tracked winds, temperature soundings, sea surface temperatures, cloud cover, and storm location. In addition, data collection and platform location systems on the NOAA polar-orbiting satellites provided the means whereby data from drifting buoys and free floating balloons were acquired and relayed to ground processing centers for subsequent use in operational forecasting. Analyses of the FGGE data have demonstrated a significant postitive impact of satellite observation on forecasting skill. It has also extended the usefulness of forecasts by at least 1-2 days and made possible 10-day forecasts in certain situations.

Prior to this experiment, U.S. satellites provided the major source of remotely-sensed observations of global snow cover and sea ice growth, formation, and break up as part of the WMO/UNESCO-sponsored International Hydrologic Decade (1965-1975). U.S. meteorological satellites will also play a key role in the evolving World Climate Research Program. Both the GOES and NOAA satellite programs are major elements of the global observing system which will provide the data to be acquired by the International Satellite Cloud Climatology Project.

Another significant area of international cooperation is the informal Coordination on Geostationary Meteorological Satellites (CGMS), carried out by Japan, the European Space Agency, India, Japan, the USSR and the U.S. Participants in this program are present and potential geostationary meteorological satellite operators. CGMS managed the successful ASDAR (Aircraft to Satellite Data Relay) operation during the FGGE, wherein wide-bodied jet transport aircraft relayed meteorological data via the various geostationary satellites. The data were then processed and disseminated worldwide through the WMO's Global Telecommunications System.

## B. LAND SURFACES

The experimental U.S. Landsat program has been a key ingredient in the development worldwide of operational land remote sensing from space and has helped demonstrate the utility of this technology for social and economic development. Some examples of this utility include surveying soils; estimating crop acreage; measuring timberlands, range lands, and water resources; mineral and oil exploration; land use planning; health and environmental protection; population estimation;

monitoring marine and coastal resources; and disaster assessment.

Landsats 1, 2, and 3 have proven the feasibility of the technology of satellite remote sensing and information extraction; Landsat D, to be launched in the summer of 1982, will have expanded capabilities and will, with the follow-on Landsat D' satellite, provide data through the mid-1980's. The availability of data from the Landsat program for almost a decade has permitted a concentrated long-term program of research and development for interpretation and application of land remote sensing data at both national and global levels.

International participation has been an important factor in developing the utility of land remote sensing. This participation, along with the non-restrictive U.S. policy on availability of Landsat data, dissemination has facilitated worldwide research in its use. Today, seventeen Landsat ground receiving stations are either operating or under development in fourteen countries. These stations provide immediate and direct access to data transmitted from the Landsat satellites.* Along with the U.S. EROS Data Center, these stations make data available on a non-discriminatory basis to users throughout the world. Many of these stations are co-located with image processing and analysis installations. These installations combine Landsat data with data derived from other sources such as field and aerial surveys to produce information for numerous applications.

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*Ground stations are operating in Argentina, Australia, Brazil, Canada (2), India, Italy (ESA), Japan, South Africa, Sweden (ESA), Thailand and the U.S. (3). A Ground station is under development in Indonesia. China and Romania are proceeding with plans for stations.

The U.S. has begun planning for an operational land remote sensing satellite system to follow the current NASA experimental Landsat program. Privately owned and operated U.S. civil operational land remote sensing services are under active consideration as the next logical step to provide data continuity. Current plans call for the phased transfer from NASA to NOAA of the Landsat-D and D' system, with NOAA assuming interim management of the operational Multi-spectral Scanner portion of the Landsat-D system until establishment of private sector services authorized by the U.S. Government. Under the NOAA-operated system, the U.S. will continue to make Landsat data available on a public non-discriminatory basis and to provide for direct read-out to non-U.S. ground stations.

## 1. Technology Development

A key factor in the utilization of land remote sensing is the digital nature of Landsat data, whereby each element of ground area is characterized numerically by the digital values of reflectances in discrete spectral bands in the visible and infrared spectra.* These elements are suitably arrayed on magnetic tape to represent a geographical area and may be easily manipulated by computer. Intensive development of this processing technique has resulted in less expensive, more efficient, high-speed data processing systems and procedures to transform the data into forms from which additional useful information can be derived. The results can be presented in a number of forms, including television display, which can be arranged so that investigators and decision makers can interact immediately with the analytical process.

Combining information derived from reliable and accurate ground-based observations and measurements with remote sensing data is necessary to realize the full value of Landsat data. For example, topographic and soil surveys may be processed and combined with Landsat data for measurement of acreage, detection of changes in surface cover and derivation of such information as forest volume, crop conditions, and soil erosion potential.

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* The Thematic Mapper (TM) planned for Landsat-D is designed to measure electromagnetic energy in seven discrete spectral bands.

Because remote sensing data are available on computer-compatible tapes in standardized formats, they can be used directly in a geobased information system and incorporated with supporting data from many sources to improve accuracy of land cover classifications. Land cover information can be updated more frequently due to repetitive satellite passes. Users can overlay multiple data sets for detection of temporal changes.

Technological developments will continue to allow dramatic improvements in the capacity and speed of systems to store and process data. The costs of processing systems have already been reduced in the last decade and further reductions are expected over the next three to five years. Most developing countries are currently using manual analysis to process Landsat data, a choice which in many cases is most appropriate to the present needs and capabilities of these countries. However, cost reductions in digital systems will offer more countries the option of using computers to analyze Landsat and ancillary data.

## 2. Applications of Remote Sensing for Resource Management

Experiences over the past decade have shown that when used in conjunction with other pertinent data, Landsat data can be useful in the management of the critical national and international resource problems which face all countries. The numerous practical applications of satellite remote sensing data are well-documented in the UNISPACE Background Paper, Relevance of Space Activities to Monitoring of Earth Resources and the Environment (A/Conf.101/BP/3) and the List of Remote Sensing Applications (A/AC.105/257/Add.1/Rev. 1 and A/AC.105/297) compiled by the UN Secretariat. For illustrative purposes, however, two examples among the many successful U.S.-sponsored technical assistance activities in remote sensing, the Aguaje Palm Inventory in Peru and Census District Mapping in Kenya, will be described here.

Kenya: While Africa suffers in general from a lack of environmental information, it also lacks data on other problems caused by overpopulation. Outdated demographic mapping and census techniques, coupled with complex cultural and land use practices, result in only limited planning information available to administrators.

Kenya is currently facing this type of problem. Many of the country's census boundaries have not been updated for years; other boundaries were never accurately mapped. Kenyan officials felt that by using Landsat imagery to map land use and vegetation boundaries, the census could be upgraded to foster more meaningful planning.

Through visual interpretations of Landsat images, vegetation and land use delineations were used to simplify and refine boundaries on existing maps. The delineations from Landsat were later combined with aerial photo-derived boundaries and existing census maps. The study revealed a general agreement on 67 percent of the boundaries, but disagreement on the remainder. The Kenya Statistics Bureau has since redefined the boundaries of disagreement to conform to population densities associated with cultural land uses such as agriculture and settlements interpreted from Landsat imagery.

Peru: Aguaje palm may well be the most plentiful palm in South America. In the Peruvian Amazon, it has considerable economic value for home and industrial use. With comprehensive management of aguaje forests, Peru could secure a domestic source of production for palm oil, edible food products, livestock feed, industrial fiber, and cellulose for the pulp and paper industry.

Until Landsat was launched, the remoteness and inaccessibility of large aguaje stands made inventory and mapping almost impossible.

In 1976, the Peruvian National Office for Evaluation of Natural Resources received a US/AID grant to determine the ability of

Landsat to distinguish stands of aguaje palm within the Peruvian Amazon. The grant project was to evaluate both digital and visual interpretation of Landsat data for the identification and mapping of aguaje palm and other forest species. Visual interpretation provided the generalized location of the palm stands while the digital classification provided greater accuracy of actual boundary lines.

The accuracy of these Landsat classifications has suggested to the Peruvian government the use of Landsat on an operational basis for this resource inventory. For many areas of the world, Landsat visual and digital data are the most efficient means of performing even the most basic resource surveys.

The AgRISTARS (Agriculture and Resource Inventory through Aerospace Remote Sensing) Program is a research and development program that could lead to a major U.S. application of Landsat data for resource management. Involving several U.S. government agencies, AgRISTARS is designed to determine the usefulness of remote sensing in improving the objectivity, reliability and timeliness of data for future U.S. Department of Agriculture information systems.

AgRISTARS research will address areas ranging from early warning of changes affecting production to land productivity estimates and pollution detection and evaluation. It will involve worldwide studies of crop production; forest and rangelands; crop conditions; and conservation and pollution.

## 3. Technology Transfer

On the basis of its own experience, the U.S. has concluded that specific efforts to develop a capability for applying remote sensing data effectively at the national, state and local levels are essential to obtain full benefit from this new information source. This experience may prove useful to other nations.

The first key factor in the U.S. technology transfer process is generating customer awareness of potential benefits through demonstration projects. Once cooperating institutions have agreed to perform a demonstration, a comprehensive plan and technical approach is prepared to apply Landsat information extraction techniques to a selected problem area. Demonstration projects involve the potential user in a low-risk evaluation of the technology, provide actual practical experience and may result in useful land cover maps of the area covered by the demonstration.

As noted in the descriptions of the applications projects in Peru and Kenya, US/AID has provided funds to start specific national projects to demonstrate the utility of remote sensing from space in dealing with development problems.

The second component is training and educational programs, whereby development workers are taught to operate equipment and to interpret Landsat data by manual or automated means. These programs are essential if an organization is to build an indigenous base of technical expertise in this area. This should include technicians to operate remote sensing facilities as well as geologists, agriculturists, etc. familiar with applications of remote sensing. Training courses for non-U.S. specialists in remote sensing are conducted at the U.S. EROS Data Center in Sioux Falls, South Dakota and the U.S. Geological Survey (USGS) field station in Flagstaff, Arizona; they are also provided on a regional or bilateral basis under US/AID or USGS sponsorship. In addition, numerous institutions in the U.S. conduct periodic seminars and symposia which provide developing country specialists with a major source of information on current developments and heighten awareness in the area of remote sensing.

Training is also available at US/AID-sponsored regional remote sensing centers in Africa and Asia. The centers in Africa serve the surrounding region and provide fundamental training in manual interpretation of Landsat data and in other photo-interpretation techniques which can be used to manipulate data from a variety of sources. The Asian center provides training in digital analysis as well as manual interpretation. The valuable work of the UN Space Applications Program and the support of organizations such as the Food and Agricultural

Organization, the World Bank and the Inter-American Development Bank in this important area is also noteworthy.

The final factor in the transfer process is technical assistance in developing the capability fully to utilize Landsat data and the advanced technology related to its application. The technical expertise of industry and universities in the U.S. is available to assist developing countries with advice on hardware, software, and the organizational aspects of planned national programs. In addition, U.S. government agencies support remote sensing research and development programs through the acquisition of new types of research data, provision of technical advice, and participation in a variety of workshops, symposia and seminars in the U.S. and abroad.

## C. FUTURE DIRECTIONS

Improvements in performance and utilization of space remote sensing systems for resource management and environmental observations are certain to continue.

The U.S. is pursuing a vigorous program of research and development to improve both the quality and reliability of its remote sensing systems and the quality, quantity, and timeliness of the data products. This research and development effort also stresses improving information extraction and distribution techniques, developing new applications of the data, and perfecting more efficient space and ground systems.

The United States is conferring with other present and potential land remote sensing satellite operators to explore ways of making these national systems as compatible as possible in order to increase the utility of the data from the various systems for all users. In particular, the United States is working to promote complementarity of nationally-operated remote sensing satellite systems. Representatives of Canada, France, India, Japan, ESA and the U.S. met in Ottawa in May, 1980, and agreed that increased consultation among remote sensing system operators in the near, medium and long term could improve those systems to meet their own needs. The operators also helped to arrange three regional meetings to brief users on their plans and to learn from users in a regional setting about their specific remote sensing interests. An African regional meeting was held in March, 1981 in Bamako, Mali, and an Asian meeting in Bangkok, Thailand, was also held in March. The meeting for Latin America was held in Brazil in November/December, 1981. These meetings fostered greatly improved communication which will benefit all system operators and users of the next generation of remote sensing systems.

New remote sensing instruments are being developed to improve measurements in the visible and infrared ranges. The primary new U.S. instrument will be a multilinear array device using solid state sensors; it will have spectral coverage and spatial resolution better than that planned for the Thematic Mapper in the new Landsat-D satellite. In addition, the U.S. program will explore the utility of the microwave spectrum, building on past experience with passive sensors (radiometers, scatterometers), the synthetic aperture radar flown on Seasat, and ground measurements and data from airborne instruments. Initial space observations with the Shuttle Imaging Radar (SIR-A) were successfully completed late last year during the second Space Shuttle test flight.

As with all remote sensing improvements, a significant portion of the work must focus on understanding the meaning and significance of new data from space observations and on developing techniques for data interpretation appropriate to the task at hand. Manual analysis techniques will probably suffice for many users of Landsat data. The most complete and comprehensive information extraction, however, will probably be accomplished by digitizing data from all relevant sources, combining it into a geobased data base, and performing the analysis by computer. We can expect substantial progress in developing a number of simpler and less expensive techniques which will be better matched to the needs of the majority of users.

## III. SATELLITE COMMUNICATIONS

Technological developments over the past decade have made satellite communications systems more adaptable to public service applications to reduce rural isolation, improve health care, education, and agriculture, and meet public safety needs in the many areas of the world presently lacking in adequate, reliable telecommunications. The U.S. has been a world leader in the development of operational communications satellite systems and has also conducted a number of demonstration experiments utilizing satellite communications for public service.

Based on the institutional initiative of the U.S. and on technology developed in this country, the International Telecommunications Satellite Organization (INTELSAT) has evolved from a small group of developed countries to a strong and viable organization of 106 members providing both global and domestic communications.

There has been continued growth in the use of commercial communications satellites and plans for domestic and regional systems worldwide are proliferating. In the U.S., the use of operational communication satellites has grown dramatically over the past decade. Already there are five competing commercial systems operated by AT&T, American Satellite, Western Union, RCA, and Satellite Business Systems respectively. These systems provide users with highly reliable communications services such as telephony, high-speed digital data transmission, facsimile, slow scan television, television broadcast distribution and teleconferencing. Several new systems which will provide similar services and such new services as direct television broadcasting are under development. These will have improved reliability and will incorporate advanced new technologies such as 24 transponder capacity, higher or dual frequency use, spot beams, and various new, advanced transmission techniques. Such improvements will lead to greater efficiencies in the use of the radio frequency spectrum and geostationary orbit resources as well as additional capacity to serve increasing numbers of users at lower aggregate costs. Decreased costs for users and improvements in the types and quality of services they provide is being accompanied by a realization that such systems may be adaptable to serve the needs of public service users in all countries. As the onboard power and capacity of operational communications satellites has increased, costs for leased circuits and earth stations have decreased dramatically, making satellite communications a more attractive economic option for public service users and traditional commercial users alike. At the same time, these systems have become more flexible and more easily adaptable to low volume uses. Indications are that the future will see further decreases in costs and economically viable multipurpose systems for shared use by the commercial revenue-making sectors and the public service sectors. The U.S. is now supporting developing countries efforts to adapt what has been learned to meet their needs.

## A. PUBLIC SERVICE APPLICATIONS

### 1. Health Care and Education

Beginning in 1971 with experiments in the State of Alaska, NASA's experimental Applications Technology Satellites, ATS 1 3, and 6 have been used in a number of projects designed to demonstrate improved delivery of vital public services to remote areas. Two-way communications experiments in support of health care and education have been conducted in hundreds of small communities in remote areas of the US, Canada, and several developing countries. Although far beyond their design lifetimes, ATS-1 and 3 remain in service.

Coordinated by a U.S.-sponsored experimenter at the University of Hawaii, Peacesat (Pan-Pacific Education and Communications Experiments By Satellite) is a network of locally-owned, funded and controlled ground terminals which use ATS-1 for two-way audio exchanges. Begun in 1971, Peacesat includes terminals at educational institutions in over a dozen Pacific island nations. It provides access to new information sources in the fields of health, education and community services. With U.S. assistance, the Peacesat participants are now exploring the possible transition from ATS-1 to commercial communications satellites for future operational activities.

In the same region, the University of the South Pacific (USP) is using ATS 1 to link its nine island campuses. In addition to two-way radio telephony, experiments are underway with AID support, using slow-scan (narrow-band, still-frame) television and low-cost micro-computer links. These satellite services permit USP to reach many distant students at a low cost and extend its expertise to a host of practical development and training needs throughout the South Pacific.

Another in the series of ATS satellites, ATS 6, provided unprecedented experimental opportunities to bring public service programs to communities throughout the world. ATS 6, launched in 1975, had the advanced capability to transmit television directly to small, relatively inexpensive ground receivers.

The most significant accomplishment resulting from the use of ATS 6 was probably the Satellite Instructional Television Experiment (SITE). This cooperative undertaking of the U.S.

and India provided one-way satellite broadcasts covering agriculture, health, hygiene, family planning, national integration, and science for youth and teacher education to an estimated 5 million people in six different "clusters" of 2400 villages in India. As ATS 6 transited from India back to North America, AID and NASA made it available for brief demonstrations with any nation along its path; 27 developing nations availed themselves of this opportunity.

Building on the technical and sociological experience which this historic experiment provided, India is establishing a domestic operational communications satellite system, INSAT, to provide community broadcast capability (as well as telecommunications and meteorology service) on a continuing basis. The first generation of INSAT spacecraft is being built in the U.S. and is scheduled for launch by NASA in 1982. This and other future applications of satellite technology originally developed for use in the U.S., Canada and Japan should make a significant contribution to education, agricultural extension work, and other dimensions of infrastructure building in the developing world.

From 1976 through October 1979, the U.S. and Canada conducted further technological and public service experiments with another pioneering satellite, the Communications Technology Satellite (CTS/Hermes), the world's most powerful communications satellite to date. Operating in the previously unused 12/14 GHz or Ku band, CTS provided further experience with the use of high-powered satellite systems for delivery of television to remote areas through small, low-cost ground stations.

Based on the public service demonstrations, the U.S. is conducting a dispersed users program to encourage the development and use of satellite communications for public services. The program includes support for some of the on-going efforts in the Pacific described above and several groups in the US, including the Public Service Satellite Consortium, an organization in the U.S. which attempts to bring together community service needs and users to enable utilization of communication satellites in the non-profit sector. Experience with the ATS satellites has also led to the establishment of the Appalachian Community Service Network to distribute, via satellite, specialized community service programming in the Appalachian Mountain region of the Eastern U.S. In addition, the State of Alaska, based on its experiences with ATS 1 and 6, now uses an operational satellite system to provide essential communications services to its many small remote villages.

### 2. Disaster Assessment and Relief Experiments

The ATS 1 and 3 spacecraft have been used on an experimental basis to provide emergency audio communications in the Western Hemisphere and the South Pacific in disaster situations caused by hurricanes, tornados, flash flooding, and earthquakes. ATS 1 and 3 have been useful because of their capability to provide communications which are mobile, versatile, and dependable under all conditions of weather and terrain.

ATS 1 was used in May 1980 for the rapid establishment of emergency communications for search and rescue operations and disaster assessment following the Mount St. Helen's volcanic eruption in the Western U.S. In the Pacific, ATS 3 served as the principal communications channel used to coordinate relief operations when waves swept over Majuro Atoll in 1980, leaving 4,000 people homeless.

### 3. Emergency Medical Service Experiments

In an effort to improve emergency assistance in isolated areas and thus save lives, experiments are being conducted with ATS 3 in the U.S. to determine the value of mobile communications via satellite for reporting emergencies, dispatching vehicles and providing two-way voice communication and biomedical telemetry between paramedics and hospital physicians.

### 4. Search and Rescue

Since the mid-1970s there has been extensive interest in using satellites to detect and locate emergency transmissions from aircraft and ships in distress. This interest has led to the international cooperative venture in satellite-aided search and rescue called SARSAT/COSPAS. The partners in this effort are Canada, France, the United States, (SARSAT) and the USSR (COSPAS). Norway has joined the SARSAT project as an additional Investigator, and several other nations have expressed interest in participating. Current planning calls for an initial demonstration phase of fifteen months beginning in 1982.

### 5. AID Rural Satellite Program

Begun in 1979, the U.S. Agency for International Development (AID) Rural Satellite Program seeks to assist the growth of rural telecommunications and allow developing countries to explore the potential of satellite communications for rural development. Ultimately the program will include three to five pilot projects of two-year operational duration, all using INTELSAT or other presently available spacecraft. Peru is the site of the first pilot project, with a second project to begin in the Caribbean in cooperation with the University of the West Indies. Other nations working with AID to establish pilot projects include Indonesia, Senegal and the Phillippines.

The AID projects will use the smallest two-way earth stations which can be used with available satellites. Such stations are expected to cost under $200,000 within the INTELSAT system and under $70,000 if existing satellites of higher power are used, making them affordable for use in market communities in a number of countries. Radio-telephone links to small surrounding communities will make possible thin-route rural networks for telephony, radio distribution, and audio teleconferencing.

AID is also engaged in research and development activities to provide lower cost-solar powered earth stations. It is planned to field test one of these earth stations in the near future.

Through training and consultations, users are being assisted in incorporating reliable communications into their rural service networks in health, education, and agricultural development. Regional universities are able to combine their intellectual skills over great distances, for teaching, research, and development assistance. Evaluation of the economic utility of these experiences, as well as other information on successful application to development problems, is being made widely available by AID through a world-wide information service.

## B. GROWTH OF SATELLITE COMMUNICATIONS

The outlook for accommodating the anticipated rapid growth in demand for space communications services is promising. The 1980s are already bringing lower costs to satellite communications through higher-powered satellites and new digital earth station designs. The impact of this trend on the utility of communications as a rural development tool may be quite dramatic. Continuing flexibility and cooperation in the international regulation of telecommunications are essential to realizing this potential. This will facilitate continued vigorous research and development in new technologies and techniques to make more efficient use of the frequency spectrum and the geostationary orbit.

Historically, improvements in technology have accommodated growth in needs for space telecommunications remarkably well. As each apparent plateau is reached, technical advances have occurred that extend capabilities well beyond present needs. This has been true in international communications with INTELSAT and with respect to U.S. domestic satellites as well. The same should be true in the future -- present concerns regarding spectrum shortages and imminent congestion of the geostationary arc will likely be amenable to technological solutions if regulatory flexibility and institutional cooperation keep these options open.

It is of particular importance that today's perceived shortages of potential communications capacity should not precipitate regulatory restrictions that will inhibit the advances which could alleviate them in the 1980's and 1990's. Inflexible allocation of orbit/spectrum resources may well impede the introduction of new technology that can simultaneously increase the capacity of orbit/spectrum resources and increase potential economic and social benefit to developing countries.

The results of the 1979 International Telecommunication Union (ITU) World Administrative Radio Conference (WARC) demonstrated that international consensus for efficient regulation and management of the frequency spectrum and the geostationary orbit is possible. Agreement was reached which allowed major increases in channel capacity for the Fixed, Broadcast and Mobile Satellite Services. New allocations for satellite remote sensing were approved and WARC provisions also will make it easier to accommodate small earth terminals and two-way communications links which are of obvious interest to developing countries.

Among upcoming ITU conferences important to the future of satellite communications, the 1985-1987 Space WARC may be crucial in determining whether a comprehensive international regulatory system can be maintained which will continue to facilitate the flow of the benefits of communications satellite technology to developing countries. In the ITU's technical preparatory work for this conference, the U.S. has submitted alternative approaches to the planning of spectrum use, together with evaluation criteria which stress the ability to accommodate new technology and to adjust to changing traffic demands.* These are features that are essential if developing countries with low volume and thin route requirements are to make use of space technology to meet their needs.

The U.S. is also conducting research and development to improve satellite communications technology and thereby facilitate its application for public services. NASA is studying a proposed thin route, narrowband, satellite communications program in the 800-2100 MHz band, designed to provide service primarily to areas of low population density.

Another important development trend involves expansion of spectrum capacity through development of the capability to use the 30/20 GHz band. Use of this band, which has enormous capacity for high volume, wide-band communications, should not give rise to near-term regulatory difficulties, and should relieve some of the pressure on lower frequency bands. Developments in this area may also lead to more efficient telecommunications technology usable in communications systems operating at lower frequencies. Among the technologies which have been under development are large and multiple-beam satellite antennas, satellite on-board switching, high-frequency/high-power space systems, and small low-cost fixed and mobile earth terminals. Multiple-beam antennas will enable extensive frequency reuse. The use of many narrow beams, each "illuminating" a different spot on the earth will permit the same frequency to be used without interference. Switching systems on board the satellite can interconnect the spot beams and route signals to their appropriate destinations.

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*United States of America. A Description of Alternative Methods for Planning the Fixed-Satellite Service. International Telecommunication Union Doc. IWP 4/1-9 March 17, 1981.

To reduce the required size, complexity and cost of earth stations, other work is in progress to develop a high-power satellite transmitter for operation at 30/20 GHz. One device under study is a traveling wave tube (TWT) capable of high output power and 10-year life. For lower power levels, solid state power amplifiers are being developed. Since better sensitivity in the satellite receiver will lower the power and cost of ground station transmitters, improved receivers are being developed.

## IV. SPACE AND EARTH SCIENCE

The United States program in space and earth science is open to participation by, and has included significant contributions from, scientists and engineers of all nations. These programs have given us new insights into our cosmic surroundings, the physical laws of nature, and our own place in the universe.

Planetary exploration has obtained samples from the moon, placed robot landers on other planets, given us our first close looks at distant worlds, and made enormous strides toward understanding the origin of the solar system and the planets in it. A major aim of these efforts is to understand the history of the Earth better by studying the geology, landforms, atmospheres, and magnetic fields of other worlds.

Solar-terrestrial studies have focused on the nature and history of the Sun, now seen clearly from new vantage points above our atmosphere. These efforts seek to understand how the Sun works, why it varies, and how such variations may affect our weather and climate in the future. A particularly important aspect of these studies involves Sun-Earth interactions such as the effects of charged particles and magnetic fields from the Sun on our own atmosphere, weather, and communications.

Astrophysical and astronomical research into the far universe beyond the solar system has led to the discovery of grandeur and violence on a scale never before suspected -- quasars, pulsars, radiogalaxies, even whispered echoes from the "Big Bang" in which the universe was formed. This research seeks to understand the physical and chemical laws of the universe as they apply over great distances or in strange environments. Now that we can lift new "eyes" above the atmosphere, we see the universe clearly -- everything from the violent bursts of X-rays and gamma rays to the cool clouds of gas and dust where stars are being born.

Research in the life sciences is concerned with the effect of the space environment (acceleration, weightlessness, radiation, etc.) on life forms, including humans, and with the special problems involved in the adaptation of humans for living and working in space. In addition, research is conducted in such areas as the analysis of meteorites and ancient terrestrial rocks for organic compounds, laboratory duplication of the organic components in planetary atmospheres, and the study of chemical evolution in the universe and the relationship of this evolution to questions of the origin of life and the possible distribution of life elsewhere in the universe.

In geodynamics, space technology is being used globally in a coordinated international program to make important contributions to understanding the dynamic processes which have shaped the face of the earth, and which are largely responsible for natural hazards such as earthquakes, as well as for the emplacement of mineral and petroleum resources. NASA has pioneered the application of satellite observations to geodesy and the use of space methods to measurements of the movement and deformation of the tectonic plates which make up the earth's crust.

It is the U.S. philosophy to seek cooperative space projects in space and earth sciences with foreign space agencies and thereby share the benefits and costs of these projects. Spacelab, the Infrared Astronomy Satellite (IRAS), Space Telescope (ST), the International Solar Polar Mission (ISPM) and Galileo, are excellent examples of major efforts now underway in which U.S. capabilities and the outstanding scientific and technological expertise of other space agencies complement one another in the development of scientific research spacecraft.

One of the principal payloads of the Space Transportation System is the Spacelab, developed by the European Space Agency under a Memorandum of Understanding with NASA. Spacelab, which will be used to conduct experiments in fields ranging from materials processing to life sciences, will be configured either as a pressurized module where one to four scientists may work in a normal environment, an instrument-carrying pallet for direct space exposure, or a combination of both configurations. A portion of Spacelab's pressurized laboratory carries equipment common to all missions and necessary for the functioning of Spacelab, such as computers, tape recorders, and checkout consoles. The other portion of the laboratory and segments of the pallet carry the experiments themselves (e.g., furnaces, microscopes, centrifuges, incubators, and photographic apparatus in the laboratory; telescopes, antennae, radars, and sensors on the pallet). In the first six years of STS operations, seven full Spacelab missions and nineteen single-pallet missions are planned.

IRAS is a cooperative project designed to carry out an all-sky survey of discrete infrared sources. The United States is producing the cryogenically-cooled infrared telescope system, the Netherlands is furnishing the satellite, and a mission control center is being established in the United Kingdom. Spacecraft testing of IRAS was completed in September, 1981 and it is now going through its final development and test phase leading to a launch in late 1982 or early 1983.

The Space Telescope (ST), an orbiting astronomical observatory built around a 2.4 meter reflecting mirror, will have the capability to view objects fifty times fainter than those now observable from Earth. Launch of ST and its in-orbit repair or retrieval from orbit for refurbishment on the ground will be accomplished by the Space Shuttle. ESA is cooperating with NASA on this project, providing the solar arrays and the Faint Object Camera for the ST spacecraft and technical support for the ST ground operations. In consideration of ESA's contribution it is expected ESA astronomers will obtain for use no less than 15% of the observing time over the lifetime of the ST project. Launch of the Space Telescope is scheduled for the first half of 1985.

The ISPM, a cooperative project between NASA and ESA, will examine the three dimensional structure (out of the ecliptic plane) of the extended solar atmosphere, wind and magnetic field environment. ISPM was originally conceived as a two spacecraft mission with one spacecraft each from NASA and ESA. A reduction in funding for NASA Space Science led to a NASA decision not to build the U.S. spacecraft. ESA is continuing with development of its spacecraft, which will carry experiments from both Europe and the United States. Spacecraft and experiment development began in 1981. The ESA spacecraft is planned for launch by NASA in 1986.

Galileo is a cooperative project with The Federal Republic of Germany (FRG) which will continue the exploration of Jupiter and its environment. A major objective of the Galileo mission, which includes an orbiter and probe, will be to determine the chemical composition and physical state of Jupiter and its satellites. The FRG is contributing a Retro Propulsion Module to inject the Galileo spacecraft into Jovian orbit, as well as other mission hardware. Launch of the Galileo orbiter and atmospheric probe is now planned for 1985.

In addition to cooperative spacecraft development projects, there has been substantial participation by non-U.S. experimenters in specific NASA missions. Non-U.S. scientists have been involved in these missions as Principal Investigators, Co-Investigators, and as Guest Investigators, providing scientific instruments and participating in data analysis. There has been important international participation in a number of historic, pioneering space science missions, including the three High Energy Astronomical Observatory (HEAO) missions, the International Sun-Earth Explorer (ISEE), the Solar Maximum Mission (SMM) and the International Ultraviolet Explorer (IUE).

Individual non-U.S. scientists sponsored by their national space agencies have participated in NASA research programs not related to specific missions. Examples of this type of activity are programs involving study and analysis of lunar samples and Antarctic meteorites. Non-U.S. scientists also participate in research activities in such areas as planetary atmospheres, planetary geology, terrestrial geodynamics, and balloon and sounding rocket flight experiments.

The U.S. has encouraged and supported the widest possible access to mission data and research results for scientists and the public. This distribution takes many forms, including open technical and non-technical publications and international conferences supported by NASA, both in the United States and overseas.

## V. APPLICATIONS OF U.S. SPACE TECHNOLOGY IN OTHER FIELDS

Space technology is in reality not so much a unique field as an evolution of terrestrial technologies to meet the particular rigors of the space environment. Requirements such as compactness, light weight, low power consumption, extreme reliability, temperature resistance and great precision have resulted in an immense and varied set of technological solutions. Many of these solutions have then, in turn, found application in new and better ways of meeting terrestrial needs. NASA has sought to make this technology more accessible to the national and international communities by heightening awareness of its existence and its potential for public benefit. Examples of spinoffs in the areas of stand-alone photovoltaic systems and health and medicine will be briefly described below; a more exhaustive catalogue is available in several NASA publications.*

## A. STAND ALONE PHOTOVOLTAIC SYSTEMS

Photovoltaic technology, for the generation of electricity directly from sunlight, was developed in the U.S. for use in spacecraft power systems. From the launch of the first U.S. satellite in 1958 until 1974, nearly all of the solar cell arrays manufactured in the U.S. were for space applications. Typically, these arrays have been non-standard custom designs and therefore costly. However, as part of increased U.S. efforts to develop new and renewable energy sources in a world of diminishing fossil fuels, intensive efforts have been undertaken to transfer photovoltaic technology to terrestrial applications.

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*Space Benefits: The Secondary Application of Aerospace Technology in other Sectors of the Economy. Prepared for The Technology Transfer Division (CODE ETD-6) at NASA by the Program for Transfer Research and Impact Studies, Industrial Economics Division, Denver Research Institute, University of Denver. January 1981.

Spinoff 1981: An Annual Report. NASA, Office of Space and Terrestrial Applications, Technology Transfer Division (by James J. Haggerty), April 1981.

Technologies for the Handicapped and Aged. NASA, Office of Space and Terrestrial Applications, Technology Transfer Division (by Trudy E. Bell), July 1979.

Schwenk, F. C. "Review of NASA Programs in Applying Aerospace Technology to Energy." Advances in the Astronautical Sciences. Vol. 44, 1981, pp. 161-181.

## 1. U.S. Programs

U.S. programs in terrestrial photovoltaic systems have involved a number of public and private research and development institutions. Their goals were low-cost systems of high reliability and durability. Efforts to demonstrate the technical feasibility of achieving a low-cost mass production capability have been integral to the program.

The major components of a photovoltaic system include collectors (the solar photovoltaic conversion devices and their interconnections), power conditioning equipment to convert DC to AC (if AC is required) and to provide regulated output of voltage and frequency, controllers that automatically manage the operation of the total system, and storage systems to retain excess energy for use during periods of low output of solar energy for some applications.

The U.S. has been developing photovoltaic systems for near-term, cost-effective applications in rural or remote areas. One of the potentially most useful applications of photovoltaic systems is the stand-alone system, to provide power in remote locations previously underserviced or entirely without electric power. Stand-alone systems are characteristically modular, direct-current installations with battery storage. The sizes range from less than a kilowatt to 15 kilowatts. On the village level, a stand-alone system could support any or all of the following services: medical clinics, communications potable water pumping, refrigeration for food, drug and vaccine preservation, grain milling, and home and work area lighting.

## 2. Applications

Demonstrations carried out in remote areas of the U.S. as well as in several developing countries have already shown that photovoltaic systems can meet basic energy needs.

The world's first village photovoltaic power system began operation on December 16, 1978 in the remote American village of Schuchuli, Arizona. This system provides 95 residents with electricity for potable water pumping, lighting, refrigeration, a community washing machine and a sewing machine.

The system is capable of pumping 4,000 liters of water per hour and includes a 40,000 liter storage tank. Fifteen refrigerators and a clothes washing machine have been installed, in addition to electric lighting.

The 3.5-kw, 120-volt DC photovoltaic array consists of twenty-four solar cell panels associated frames and support structures (designed to withstand high winds) and batteries. The system's reliability has been demonstrated by the fact that it has been operating approximately 99% of the time since its inception.

A similar 120-volt DC solar cell system has been installed in Tangaye, Upper Volta to power a grain mill, water pump and lights. The original 1.8 kilowatt (peak) system which became operational March 1, 1979, was enlarged to 3.6 kilowatts (peak) in May, 1981. This is the first demonstration of the modularity of solar cell systems in the field. This system is capable of pumping 15,000 liters of water and milling 400 kilograms of grain per day, enough to meet the daily requirements of one-third of the 2700 inhabitants of this remote village.

In conjunction with the U.S. Center for Disease Control, a solar-cell-powered refrigerator/freezer has been developed to provide cold storage for vaccines at remote medical posts in developing countries. The first of these has been installed in India. Other potential sites are the Maldive Islands, Gambia, Ivory Coast, Colombia, Peru, Zaire, Liberia, Upper Volta, Philippines, Indonesia, Tunisia, Morocco, Egypt, Dominican Republic, Honduras, Haiti and Guatemala.

Solar cell systems are also being designed to meet the basic electrical requirements of typical rural health facilities. Early installations are planned for Ecuador, Guyana, Kenya, and Zimbabwe. A joint project with the Government of Gabon is being initiated to install solar cell systems in four villages for health, water, education and public lighting purposes.

A Renewable Energy Project has been initiated with the Government of Tunisia. This project will demonstrate the ability of solar and wind technology to perform work and supply the minimum services necessary in a village and in rural agricultural applications. This project will include a 27 kilowatt (peak) solar cell system.

A Renewable Energy Field Testing Project is in the planning stage with the Government of Egypt. Solar-cell, thermal, and wind systems are being considered to test the technical, economic, and social feasibility of renewable energy systems and to provide analysis, education, and training to support replication and diffusion of promising applications.

In support of the AID Rural Satellite Program, NASA is investigating solar cell power systems to meet electrical needs such as earth stations, terminals and repeaters. Preliminary electrical requirements have already been established and conceptual design and cost analyses initiated.

## 3. The Future

Experience so far has shown that stand-alone photovoltaic systems can meet many of the basic electric power needs in remote areas and provide a realistic energy alternative for developing countries, improving the quality of life and increasing economic opportunity for rural populations. As costs decrease, stand-alone photovoltaic systems could become the most attractive source of decentralized electrical generation in many developing countries.

## B. SPINOFFS IN HEALTH AND MEDICINE

New materials and equipment, originally developed to meet the demanding requirements of space travel, have also been applied on earth to meet health and medical care needs. A few examples of such "spinoffs" are described below.

### 1. Automated Microbe Detection and Identification

A compact and fully automated microbial detection and identification system was developed by U.S. industry for the space program. The system is capable of simultaneously analyzing up to 240 specimens of body fluids for the presence of harmful microorganisms within 4-13 hours, a reduction of up to 80 percent from time required for traditional laboratory methods. This combination of capabilities can be of significant value in dealing with emergency medical problems, such as epidemics, and in areas where trained medical laboratory personnel are scarce or absent.

## 2. Pocket-sized Fluoroscope

The Lixiscope, a pocket-sized X-ray image intensifier, was developed by a researcher at NASA's Goddard Space Flight Center from instruments originally intended to detect celestial X-ray sources. The unit requires only a weak radioactive source for operation, and is powered by its own batteries. As a result, it offers the potential of bringing small-member x-ray diagnostic services to medical and dental patients in remote areas where power for conventional x-rays is unavailable.

## 3. Light-weight Emergency Blanket

Astrolar II is a material originally developed for use in space suits, consisting of a thin deposit of aluminum on the surface of a non-woven fabric. An extremely effective insulator, the material is now being used in emergency blankets for treatment of hypothermia victims, because it reduces loss of body heat by up to 80 percent when wrapped around the patient. Emergency rescue services are also using these blankets for burn victims.

## 4. Freeze-dried Foods

The process for freeze-drying foods was developed in response to the requirements of manned space flight, but the resulting products, which require no refrigeration, have long shelf-life, and can be reconstituted simply by adding hot or cold water, are finding wide application on earth.

## VI. US SPACE TRANSPORTATION SYSTEM

The first launch of the Space Shuttle Columbia on April 12, 1981 and its second successful mission in November 1981, marked the beginning of a new era in the exploration of outer space. This new form of economical, reuseable space transportation offers opportunities for broader participation by the entire world community in the peaceful uses of outer space. The U.S. Space Transportation System (STS) will lead to new opportunities and advances in many areas of space technology and applications, to the added benefit of social and economic development worldwide.

The Space Shuttle, consisting of the orbiter, the external fuel tank and two solid rocket boosters, is the major element of the U.S. STS. Other flight elements are the Spacelab which is being developed by the European Space Agency (ESA), propulsive upper stages to place payloads into higher orbits than attainable by the Shuttle, and the Remote Manipulator System which was developed by Canada. Follow-on developments and free-flying complementary systems for enhancing and augmenting the Shuttle's utility are also being planned.

The Shuttle orbiter will carry crews of two to seven for in-orbit flights of up to seven days. The Shuttle can place into orbit payloads weighing from 23,600kg to 29,500kg, depending on the parameters of the desired orbit.

Costs to the individual payload customer will be less than comparable costs on expendable launch vehicles, due to the Shuttle's ability to carry multiple payloads. U.S. reimbursable launch services will continue to be available to interested countries and international organizations for satellite and other space projects for peaceful purposes on a non-discriminatory basis.

International interest in utilizing Shuttle and Spacelab is already considerable. Australia, Canada, Colombia, the Federal Republic of Germany, India, Indonesia, Italy, Japan, Luxembourg, the European Space Agency, and the Arab Satellite Communications Organization, have already reserved launches, and a number of other countries are expressing interest.

Twenty years of intensive planning and development utilizing the highest technological capabilities of the U.S. space program will bear fruit in late 1982 when the Space Shuttle enters its operational phase. By permitting more frequent launches at a lower cost to the user, the U.S. STS will offer more opportunities for sharing data and for actual participation in space activities, ranging from dedicated or shared payloads to small self-contained payloads and experiments of opportunity on a space-available basis. In addition, the Shuttle will permit many space-based activities to take place that were heretofore precluded because of cost and weight constraints, the absence of man, and the rigors of launch. The unique attributes of the space environment--lack of gravity, a synoptic and unobstructed perspective of Earth and its atmosphere, nearly perfect vacuum environment, and an abundance of solar energy and heat dissipation capacity--will become more accessible to mankind. Plans for in-orbit maintenance and the return of satellites and payloads from orbit offer exciting prospects for reduced costs and expanded opportunities in space.

### 1. Telecommunications and Broadcasting

The U.S. STS will place into orbit larger and more powerful communications satellites employing new, more efficient technologies. This will allow marked reductions in the complexity and cost of earth terminals and lead to more efficient use of the frequency spectrum. Such advances will permit more users to have access to communications satellite services.

### 2. Remote Sensing

With the relaxation of size and weight constraints on remote sensing systems, as well as the prospective availability of multi-purpose orbital platforms, improved remote sensing capabilities will become available for research and operational use.

### 3. Industrialization

Industrial activities in space is a long term goal of the U.S. civil space program, and the Space Shuttle is an important milestone in preparation for this future reality.

An initial step toward space industrialization will be joint activities between NASA and industrial firms to advance materials processing in outer space. Utilizing the advantages of zero gravity and abundant solar energy, experiments in this area during early Spacelab missions may result in translating theoretical possibilities into improved processing of materials for practical applications and trial production by the late 1980s or early 1990s. These efforts will help us to learn if the space environment can offer new technical opportunities that are either competitive with terrestrial alternatives or entirely unique and exclusive. Through the knowledge gained from low gravity experimentation, it could also provide unique technological aids for the maintenance, consolidation, and improvement of efficiency and competitiveness of earth-based industry, and develop new technologies and processes not achievable on Earth.

## VII. SUMMARY/CONCLUSION

This paper has reviewed aspects of the U.S. civil space program of interest to the world community and, in particular, the developing countries. The history of space exploration is still very short, but already operational systems link nearly all countries which utilize meteorological and communications satellites. Other types of space systems in such areas as land remote sensing are moving from the phase of demonstrating technical feasibility to the establishment of operational systems. These systems, both operational and experimental, have already contributed in direct and indirect ways to the improvement of life on Earth and human knowledge of the Earth and the solar system. The U.S., which encourages sharing of benefits through openness to international participation in its civil space program, is proud to have played a key role in these developments.

As the transition from experimentation and demonstration of space systems to the operational phase has occurred, participation in space-related activities and realization of practical benefits from products and services of space activities have increased dramatically. INTELSAT is a healthy and growing organization; INMARSAT has just begun operations and is growing in size; meteorological satellites provide direct readout of weather data worldwide; Landsat data is used in over 100 countries, plans for regional and domestic communication satellite systems are proliferating and the U.S. Space Transportation System will shortly enter its first year of routine operation.

United Nations organizations such as the UN Committee on the Peaceful Uses of Outer Space, the WMO and the ITU have been important to the progress that has been made in the development of international cooperation in the peaceful uses of outer space. It is hoped that such cooperation will continue, allowing states to carry out their space activities in an environment of openess and flexibility. The U.S. intends to be a constructive participant in the future activities of these organizations.

One of the major thrusts of the U.S. civil space program will continue to be making the beneficial applications of space technology and space science available to more people in more countries. In working toward this objective, the U.S. will continue to pursue vigorous programs to develop new technologies and improve those already in existence. At the same time, AID will be assisting nations to make full use of current space capabilities for their development needs. Space science programs, while their benefits to the developing world may be less obvious, will yield information which will broaden our understanding of the history of the Earth, the structure and operation of its atmosphere, and the future influences of the Sun upon our weather, climate and communications. The U.S. will continue its efforts to transfer to others the "spinoff" technologies resulting from our space programs. Lastly, the inception of an operational U.S. STS with its capabilities to place larger, more powerful payloads in space will provide the base for new opportunities in space exploration, and for further developments in all areas of space applications

The benefits of space activities have only just begun to be enjoyed by the world community. The new knowledge gained from future space activities will be vital in helping the world community deal effectively with the pressing global resource and environmental problems faced by all countries regardless of their level of social and economic development. The U.S., as the world leader in the exploration and peaceful uses of outer space and the development of space technology will continually strive for new knowledge in this area, knowledge which will be used for the progress of all people.

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